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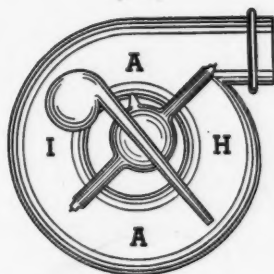
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QUARTERLY



VOLUME 12

SEPTEMBER, 1951

NUMBER 3

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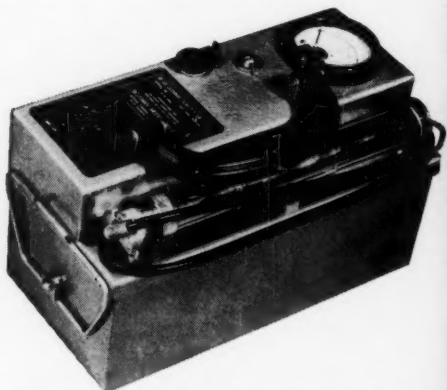
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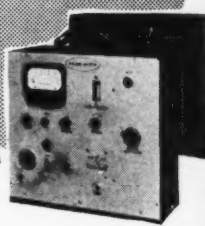
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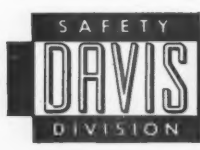
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Selling Industrial Hygiene to Management
— The Official Agency —

LEONARD GREENBURG, M.D.

Director, Division of Industrial Hygiene and Safety Standards
New York State Department of Labor

THE CHIEF function of the official industrial hygiene agency is to maintain safe and healthful working conditions in industry. In certain states, the ends to be achieved are set forth in the Public Health or Labor Law. For example, in the Labor Law of the State of New York, the Industrial Commissioner is charged with the duty of protecting the workers as follows:

"Section 200. General Duty to Protect Health and Safety of Employees—All places to which this chapter applies shall be so constructed, equipped, arranged, operated and conducted as to provide reasonable and adequate protection to the lives, health and safety of persons employed therein. The board shall make rules to carry into effect the provisions of this section."

In certain jurisdictions the charge is not so specific but is rather a part of the general police power of the state and of the Health or the Labor Commissioner. In practice there has been little question of the possession of authority in a given area—for with few exceptions, the power to enforce is well accepted.

While the objectives of industrial hygiene are well crystallized and accepted in most areas, it is important to note that the means of attaining these ends are often left to the decision of the industrial hygiene administrator. For example, in a

certain health department, the Division of Industrial Hygiene locates a definite health hazard after study and test. The problem is to achieve correction and control. It is at this point that the enforcing authority has leeway in method. In general, in labor departments, the enforcement of safety rules and regulations is achieved in a somewhat routine fashion, i.e., the inspector is required to issue the orders immediately on perceiving the so-called violation. With respect to health violations, the industrial hygiene division may, after finding a violation, move to obtain correction by agreement. Not being successful after a reasonable period, the Division of Industrial Hygiene may forward the papers to the Division of Inspection for necessary enforcement. The important fact is that the industrial hygiene division has considerable latitude in arranging for compliance with its requirements for the control of a health hazard.

The Education of Industry

DURING the last 10 years, health has become a popular subject, and along with the increase of knowledge and interest in personal and public health matters, there has gone a corresponding increase in knowledge and interest in the field of industrial health. The work of the universities, the insurance companies, the Industrial Hygiene Foundation, the National Association of Manufacturers, the Public Health Serv-

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ice and other agencies has served to inform the industrialists of this country about health, and particularly, health in industry. This has made the task of what must be done today a relatively simple one.

The key to educating industry to appreciate industrial hygiene lies in demonstrating that healthful plant working conditions are the basis of: (1) good management; (2) good working conditions generally; (3) good union and worker relationships; (4) decreased labor turnover and lost time, and (5) decreased production losses and, therefore, costs of production.

In other words, there are so many axiomatic and obvious reasons why healthful working conditions are good for management, that it is only rarely that this direct approach fails. Printed matter has also been of great aid. Lastly, factory inspectors should be utilized in the education of industry with regard to accident prevention, industrial health and hygiene, and public health.

Personnel With Whom to Deal

AT THIS POINT, it is well to introduce a fundamental consideration, namely, the influence of company size on the whole problem of industrial hygiene and industrial health.

The size of the company and plant determines its administrative organization and the choice of persons with whom the industrial hygienist may deal. In the small plant, one man may make all important decisions—he may purchase as well as sell and, at the same time, be factory superintendent. Such an organization leaves little to the choice of the industrial hygienist. He must see the boss of the establishment. At the other extreme, one may find a large organization where function and jurisdiction are limited and well defined. Here, there may be an industrial hygiene department, a medical department, a department of maintenance, a complete engineering department, a personnel office, a factory manager, a plant superintendent, and one or more safety engineers. Between the small plant and the large one, there are many gradations in size and in kinds of personnel. Thus the choice of the person to whom to report is often made for the industrial hygienist by the com-

pany organization. The plant manager or the plant superintendent must be acquainted with the efforts of the industrial hygienist. If industrial hygiene technical personnel are a part of the organization, they will be consulted and the problem explored with them. With reference to control ventilation techniques, the plant engineer will naturally play an important role. Use should be made of any and all technical services available at the plant, including the plant physician and the medical department.

As a general rule, no matter whom the industrial hygienist deals with regarding the details of the problem at hand, he should start his plant contacts high up in the managerial scale. Management is entitled to this presentation on a high level and, if it is not forthcoming, work at the plant may meet with delays and unnecessary restrictions. All of this may easily be avoided by a simple explanation to someone high in authority.

Translation of Results

THERE ARE many ways in which industrial hygiene results may be translated into terms usable by plant personnel. For instance, with reference to exhaust systems, the speed of motors and fans may easily be checked against the original design. Adequate maintenance, a most important factor in the operation of exhaust equipment, constitutes a large industrial hygiene area which may be translated into terms usable by plant personnel.

The difference between good and poor housekeeping may be a determining factor in the difference between industrial disease due, for example, to solvents, and protection from such solvent vapors. Surely, it should be possible to convince plant personnel of the importance of housekeeping in such circumstances. Management is intelligent enough to know that the use of a non-toxic solvent as a substitute for a toxic one is good business, and this industrial hygiene lesson is being translated into usable terms every day.

Channels for Employee Education

THE INDIVIDUAL employee receives the major portion of his industrial hygiene education from three sources:

1. Such material as comes to his attention, chiefly in writing or printing, from the official agencies. Viewed from the over-all point of view, the amount of such material coming into the hands of the average worker must be considered to be rather small and limited in scope. At the present time, it cannot be said that this occupies as large a place in the program as it should. There is, of course, real difficulty in spreading information by this means, and, considering the number of workers in this country, it must, in general, be concluded that this avenue of approach is costly and, perhaps, somewhat inefficient.

2. The second avenue of education is that provided by the labor union. At the present time, this approach is used with great efficiency in certain unions and not at all in a far greater number. That much can be done, has been demonstrated by those unions which have shown a deep interest in this aspect of the industrial health problem. The union approach has something to recommend it, for a worker usually has confidence in everything that comes to him from his own self-supported union.

3. The third and, perhaps, most important channel of industrial hygiene education is that provided by the employer. Here, the education is by word of mouth and comes from the foreman to the shift boss and directly to the worker. It is clear that the importance of the foreman and the shift boss cannot be over-estimated. A plant that intends to conduct a good educational program in the field of accident prevention and industrial hygiene can achieve tremendous results by teaching the foreman and shift boss and, in turn, have them teach the individual worker. The instruction obtained in this fashion is usually pertinent to the specific plant and process operation at hand and is of the utmost value in maintaining safety and health in the plant sponsoring the program. It is usually the plant management who decides on the instruction the worker shall receive, with of course, a certain area devoted to the education by the union.

Getting Corrective Action

ALL CORRECTIVE action must rest on the firm basis of studies which demonstrate a hazard or the existence of conditions

which might tend to injure the health of the worker.

Obviously, it is not necessary to prove that anyone has actually been injured. The dictates of public health and preventive medicine make it mandatory that this be so. Nevertheless, if one is to expect to achieve corrective measures one must unequivocally demonstrate that there is something that really requires correction. This need must be translated into plain talk comprehensible to lay management, if the size of the plant compels the industrial hygienist to deal with non-technical personnel. Usually, this is not too difficult and, as a rule, can be demonstrated in a simple fashion. This demonstration may be reinforced by quotations from rules or regulations and the use of medical or industrial hygiene references which carry conviction.

In order to achieve control, it is important to demonstrate to management why control is to the benefit of both the organization and the worker. This should be made so clear that the self-interest of management should motivate the action desired by the hygienist. Corrective measures should be designed so as to be achieved at the lowest possible cost consistent with the end. There is no reason why management should be asked to spend more money than absolutely necessary in order to achieve protection. Here, as in all engineering work, the elements of cost and economy should be given adequate consideration.

Management should be given guidance and assistance in deciding what to do and how to do it. This is really a part of the educational work of the official agency. In fact, the official agency should rarely be called upon to do fundamental research, with the important exception of that type and kind of research which can be used to assist management in achieving control results. In this connection, I might mention that at the present time, we are conducting a study of dust control in the making of common brick and we hope to use the results of this research as a basis for engineering control in all of the brickyards of the state.

Management should be given a sufficient period of time for compliance with recommendations. Only in the case of extreme hazards which may cause death on short

notice, need the action be very rapid. For the most part, there is sufficient time for conferences and for the purchase of necessary equipment, including the usual delays. No good can come from putting undue pressure on an industry to move with extra rapidity unless there is urgent need for it.

Only after all cooperative efforts have failed to produce results, should the law be invoked and legal action taken. In our experience, this is a rare occurrence. Ameri-

can labor and industry appear to be of one mind in the importance of the subject of health and health maintenance. In many years of experience, I still have to meet the employer who is not himself so interested in health, that he cannot visualize the problem from the point of view of his workers.

I am happy to repeat again, that in my experience, industrial hygiene has come a long way in the last 30 years.

Selling Industrial Hygiene to Management

— The Insurance Company —

E. G. MEITER, Ph.D.

Director, Industrial Hygiene Division

Employers Mutual Liability Insurance Company of Wisconsin
Milwaukee, Wisconsin

TODAY the great majority of employers cover their compensation losses due to accidents and occupational diseases by insurance. They also, and rightfully so, expect their insurance carriers to suggest ways and means for preventing these losses. It, therefore, becomes important that effective loss prevention programs be adopted, an integral part of which is a good industrial hygiene program. If this is not done, many losses will continue and both employer and insurance carrier will lose money. On the other hand, with the adoption of sound preventive programs, everyone gains—the employer by reduced insurance premiums, the insurance company by reduced losses, and, most of all, the employee, because a compensation check is no substitute for the regular pay envelope.

Naturally, to develop an effective industrial hygiene program, it must be sold to top management so that management becomes a cooperative partner, rather than following a program reluctantly, which means ineffectively.

While the motives behind an industrial hygiene program sponsored by an insurance company may be different from those of other agencies, the end results are the same, namely, the preservation of health through the recognition, evaluation and control of environmental causes of disease. Consequently, there is no need for conflict

between industrial hygiene programs developed by the employer himself, the official agencies, or the insurance carrier. In other words, well designed programs should supplement each other, rather than be conflicting.

1. *How does one educate an industry to appreciate industrial hygiene?*

In preparing to sell the benefits of an industrial hygiene program to industry, we must bear in mind that management in general is afraid of "what's new" until it has proved itself. We can, therefore, expect to receive some opposition to any changes we may suggest. The machinery, processes and operations in use have been developed over a period of many years, and managements are proud of their accomplishments. Quite frequently the operations are standard for the industry and have been inspected by both official and non-official agencies without too much comment on health hazards. Then the industrial hygiene engineer appears on the scene and may point out many imperfections and necessary changes for correction. The coming in of such "outsiders" may be resented unless the proper approach is made.

Laying the proper groundwork, or educating management to appreciate the benefits of an industrial hygiene program is, therefore, important before we can expect to receive much cooperation. In my opin-

ion, ability or know-how is the prime requisite for accomplishing this. While no one person can master all the professional skills required by industrial hygiene, such as engineering, chemistry, medicine, and physics, we can by proper study, training and experience become what we call a "qualified interpreter," or one who in general terms can explain to management the benefits to be derived from an industrial hygiene program, and the pitfalls to be encountered if such a program is not adopted. During this phase of the discussion it is well to concentrate on "what is to be done."

Assuming, now, that the employer now has sufficient interest and that there is a meeting of minds on "what is to be done," the next phase of the problem is "how to do it." This latter phase may require a thorough industrial hygiene survey, including air sampling and ventilation measurements. Following such a survey it is not enough to tell an employer that the air in his plant has so many million dust particles per cubic foot of air of a specified free silica content; or that the lead content is so many milligrams per cubic meter; or that the benzol content is so many parts per million—because of which he needs an industrial hygiene program. What he wants to know is the practical significance of these figures; what additional ventilating facilities or other control measures are necessary; what type of medical examinations should be made; what are his legal responsibilities. Answers to these questions will invariably sell the industrial hygiene program to management.

We can make our selling job easier and more effective by advancing an industrial hygiene project at the right time, as for example, at the time of a change in the occupational disease laws of a state, or the awarding by an industrial commission of an unusually costly compensation claim, or newspaper, radio or television publicity given a new hazard. All these things can be used as effective sales material. At such times management is desirous of having a correct interpretation of the publicity.

2. What plant personnel does one report to and discuss his work with, and why?

The selection of the proper plant personnel to contact regarding industrial hygiene problems is highly important.

The insurance phases of a business are usually handled by the secretary-treasurer, treasurer, or comptroller. For this reason the insurance buyer, whatever position he may hold, is usually designated by management as the official contact for insurance company representatives to see, whoever they may be.

During the call on the insurance buyer, and having briefly outlined to him the purpose of the call, it is advisable to suggest to him that he call to his office a member of the plant operating personnel to serve as plant contact. This plant representative should preferably be a policy-forming executive, who has direct knowledge of the plant operations and potential hazards. The purpose of the call is then again outlined, and the insurance buyer then usually issues instructions to the plant contact as to what general action should be taken. We then proceed to the office of the plant contact and ask him to call in additional plant personnel, depending on the plant size or plant organization.

The proposed program is now outlined in detail before the entire group. This procedure results in obtaining additional suggestions for corrective measures, while at the same time impractical recommendations are pointed out which can then be revised. Such a conference usually results in a meeting of minds, and the adoption of a tailor-made program to fit the plant needs. The adopted program is then written up in clear, concise form, and copies submitted to both the insurance buyer and the plant contact.

If some such procedure is not followed and roundabout channels are used, it is practically impossible to get the message across correctly, and the proposal is likely to fall by the wayside.

3. How can industrial hygiene results be translated into terms usable by plant personnel?

Industrial hygiene results can be translated into terms usable by plant personnel by adopting correct operating procedures, which will reduce the concentration of dusts, fumes, vapors and gases to a minimum, and by the adoption of good house-keeping practices, and the wearing of personal protective equipment where necessary. In addition, periodic checks should

be made of the ventilating system. Simple static suction tests are usually sufficient in determining whether performance is continuing satisfactorily.

4. *Through what channels does or should the individual employee receive his industrial hygiene education?*

The industrial hygiene education that an employee receives is usually of two types, medical and engineering. The medical aspects of an occupational disease hazard and the general personal precautionary measures to be taken for its prevention may well be discussed with the employee by the examining physician during pre-employment and routine physical examinations. Further information may be given by the industrial nurse should the employee visit the first-aid room.

The engineering aspects, including reasons for protective measures, should be received through the same channels as the job instructions.

From my own observations, too little attention is paid to job training with reference to industrial hygiene. This particular

phase of the program may well be extended.

5. *How to get action of a corrective nature as a result of one's studies?*

Having once established a plan for action, and having received approval by the proper representatives of management, the final phase is proper "follow-up," after a reasonable time from the original call. This is for the purpose of checking as to what action has been taken, and what still remains to be done, and clearing up any misunderstanding. If the follow-up call is not made in person, some minor objections, either real or imaginary, may cause the proposed program to lag or be entirely abandoned.

Conclusion

IN CONCLUSION, it is obvious that no single set of rules or procedures can be laid down for selling industrial hygiene to management. Individual situations will determine what selling procedure is to be used. In general, the suggestions I have mentioned have been helpful from our standpoint.

Selling Industrial Hygiene to Management

— The Smaller Industry —

ROBERT P. GLEASON

Industrial Hygienist, Sylvania Electric Products, Inc.
New York

THE FIRST time that I was complimented for doing a selling job in industrial hygiene, I had not realized that I had made a sale.

I was working for an insurance company and was called from the laboratory to attend a meeting with safety representatives from a shipyard. A new man, Jones, a safety engineer, was to go along with me. It was important that we make a good impression, for it was through the safety representatives that each of us was to get things done on safety and industrial hygiene problems in the yard. As I rode to the meeting, my thoughts were only of technical aspects of shipyard industrial hygiene problems.

We arrived at the meeting all too soon and met our two contacts. It seemed as if they were the biggest men I had ever seen:

both were well over 6 ft. 3 in., and weighed at least 275 lbs. They could have been wrestlers instead of safety engineers. It was my feeling that they were hired only because either one could take on half the yard with one hand tied behind his back. They were definitely not technical men.

The afternoon wore on, and as far as I was concerned, the meeting was a "dud." I had said nothing, and nothing was spoken of industrial hygiene.

When the meeting was over, we were invited to have a drink. Apparently, my co-worker Jones, was not up to snuff, for he passed round after round. Later that night as I wove homeward, I wondered what the impression of us was. I wished I was Jones the next morning, until I went to the boss to find out how we were received.

He greeted me warmly: "I guess Jones

is a little stiff," he said, "and I may have to use somebody else on that job; but, they think you're a great guy." Then he added, "Nice selling job."

The point of this story is that in selling anyone anything, one has to understand the most effective approach to the individual involved. Before you sell anything, a need or a want must exist or be created; and then someone has to "buy" your product to satisfy this want. Selling a refrigerator to an Eskimo is supposed to be the ultimate of selling, and we would hardly expect anyone to make such a sale—no matter how well he knew the characteristics of a refrigerator—unless he knew the characteristics and thinking of the Eskimo. I am sure that industrial hygienists know their product, but I am not so sure that industrial hygienists know the thinking of the group we call "management."

What is management? To all too many, management is the indefinite "they" that a disgruntled employee may speak of when he says "they won't give me a raise." I think we need a simpler definition of management because in order to understand an effective approach to management, we have to know what management is.

Probably the simplest way to define management is merely to give the classification: (a) top management; (b) middle management, or plant management; (c) supervision. I have limited my paper to this basis alone, by giving my impressions of each type of management thinking in relation to industrial health and hygiene, based on my experience in my own company—a company of over 20,000 people and most decentralized in operations. To know what management thinks of industrial hygiene is the first step in a successful selling program. I am not going to try to discuss the qualifications of the industrial hygienist or try to cover personal phases of selling to any appreciable degree. We will start with top management thinking.

Top management is understood as the group that sets policy, and is responsible for the progress of the company as a whole. Top management is, or is not, going to give all-out support to a health program. It is a decision based on many factors, with the result that top management believes that it is making a sound investment

with the money it will spend or cause to be spent. Top management sees the whole picture, but its attitude will devolve throughout the organization. The fact that top management has decided on an industrial health or industrial hygiene program is the biggest factor toward success that the industrial hygienist requires, and if the industrial hygiene work is sound, and management education is thorough, this program should continue satisfactorily. If the program is not sound, repercussion will be felt from lower management with the possibility of re-examination and ultimate rejection. I once heard about a company that began an industrial hygiene program with much fanfare. The first job was the elimination of a silica hazard by the construction of a pneumatic conveying system at a cost of \$40,000. Someone slipped. The system would not handle moist materials. This mistake in ventilation design set back industrial hygiene progress in this company by 10 years.

An excellent expression of top management thinking on industrial health and hygiene is that of Mr. William B. Given, Chairman of the Board of the American Brake Shoe Company. Mr. Given is recognized as one of the outstanding men of management in industry today. His attitude on industrial health is included in his book "Bottom-Up Management," and this section might be good reading for any industrial hygienist.

The incident which was largely responsible for Mr. Given's thinking along industrial health lines was a telegram he received on a train back in 1933. The telegram stated that 34 silicosis suits for over two million dollars had been filed against his company by employees of one foundry—and American Brake Shoe operated 39 foundries at that time.

Any industrialist with this problem will certainly realize the importance of industrial health as a top management function. Many never get the opportunity. It almost goes without saying that American Brake Shoe is sold on industrial hygiene.

I think that we should not readily condemn top management for a health hazard in one of its plants. Health hazards are not necessarily the result of poor management, but management may be measured

by the interest it takes in preventing and correcting health conditions. To use an analogy, most of us consider ourselves as top management in our own affairs; but, for example, how many of us actually know what our limits of liability are on our automobile insurance policy? A dented fender to someone's 1934 Hupmobile does not mean much, but a collision with a school bus would certainly make one think. We all feel that we are health and safety conscious to a high degree, but are our cars and homes in the best condition we can make them? Top management and everyone of us need constant reminders to understand and support any program.

There is a lot to management; there must be; management positions pay well. Top management has never been so concerned with public and employee relations as it must be today. Top management knows that its most valuable asset is its employees, and for this reason good management is basically industrial health conscious. If I may quote from Mr. Given:

"Industrial management is constantly being given new tools to use in making plants healthier places. The job of the businessman is to put them to use, and to do it with high zeal. We in management positions may understand little of the technical aspects of industrial hygiene. But that does not matter greatly, if we employ a medical director of the right caliber and back him up with the requisite equipment, funds and authority."

We, as industrial hygienists, are not going to sell top management directly on industrial hygiene. The medical profession will do that, and we believe that the medical profession realizes the importance of industrial hygienists in presenting a well rounded health program to top management. We, as industrial hygienists, can sell to top management indirectly by doing a sound, businesslike job in all our endeavors and contributing to the over-all health program.

The industrial hygienist has a selling job in his own right in the middle management class—the plant manager. At the outset, I would like to say that the industrial hygienist should not spend too much time in trying to sell to staff people of the middle management class—unless he can make a

staff man an ally. The people to work with and to sell industrial hygiene are the operating people. How many of you insurance company or state industrial hygienists haven't been told by your superiors on a visit, "see the plant manager." The same is true within industry. The plant manager is a king in his own domain. If he is doing a good job of producing and making money for the company without conflicting with the ideals and policies of the company in questions of employees, community and public relations, and performs as is expected in other over-all company matters, he will continue in that position come hell or high water. A plant manager wields a lot of power, and can make or break almost any program you can set up. Plant managers are of all types and characters, but they are the ones you must work with, and they are the ones that really have to be sold. There is no fooling about it, and to sell a plant manager you may have to use every rule or trick in the book. But, first, try to educate the plant manager or his organization as to what the job of an industrial hygienist is and let him know what you can do for him. He has plenty of problems, and some for the industrial hygienists.

I remember my first visit to one of our plants, in Pennsylvania. Our safety engineer and I entered the plant just as the plant manager was leaving for a business trip. As he did not have much time, I was merely introduced as an industrial hygiene engineer who was going to make a survey of the plant. I guess he had never heard of industrial hygiene, for he said to the safety engineer in all sincerity, "Okay, Jim, take him around. All of the toilets are in good shape." To him an industrial hygienist was a professional janitor.

Now, after three years, the plant manager is somewhat better informed about industrial hygiene; not especially so, because there have been few health hazards in his small, radio-tube plant, but our contacts with him have been enough to establish a working relationship even though the contacts were but simple industrial hygiene problems such as improved degreaser ventilation, and the satisfactory operation of a spray booth. When he is in our New York office, he will often stop

over to ask a few technical questions about chemicals and the hazards of plant operation. Sometimes he goes out of the realm of industrial hygiene when he asks if we have any ideas on how to get rid of algae in cooling water. Anyway, we like his questions; for they show confidence in us that we are helping to make his load lighter, that we are contributing in some way to efficient production (which is a basic consideration of plant management) and that our recommendations on health hazard situations will be given attention.

On the other hand, we have plant managers who are well aware of the job that industrial hygiene personnel can do for them because they have had significant health problems in their plants. They may have been indoctrinated into industrial hygiene by the work of the state agencies or the insurance carriers. These men do not have to be sold. They request a survey, a plant visit, or tests, and send memos about a proposed change of operation for comment on the health hazard. They know what an industrial hygienist does and they put him to work. They want their operations safe and efficient, and expect the industrial hygienist to do his part on a sound and reasonable basis. I have had some contact with two men in our organization who can be placed in this category. I have much respect for their management ability, for their plants have been tops in all respects. I was not surprised when these two men were raised to positions of vice-presidents in our company last December. To me, it was just another instance that good industrial hygiene—or good industrial health—is synonymous with good management at any level.

Sometimes, you will have to use every appeal you can think of to get a job done—to sell a plant manager. Generally, a good bet is logic, but logic has its pitfalls and may be a time-waster. However, a good formula for success is being right, and logic helps.

A second appeal is the personal and material gain for the plant manager. This is basic. If you can show how a job can be done well and economically, you're made. Cost is most important. Anything that will contribute to efficient production can be sold with little effort.

A third is recognition of responsibility and the humanitarian aspect of occupational disease. This is a good angle, but it must be rational and not "oversold."

Loyalty to the company, pride in his plant, or a job well done, rivalry or conformity in plants or divisions are similar appeals which can often clinch a sale with a plant manager.

In my opinion, fear is a poor appeal. Occasionally it may be a good thing to drop a hint of some of the bad things that could occur from a misuse of a toxic substance. But, the fear approach should be used with caution, because if it does not stick, your reputation has suffered. Don't cry wolf until you have to; and know your situation thoroughly before employing this incentive.

I think that an appeal to management's leadership, utilizing all possible means of individual motivation, is a constructive outlook towards accomplishment of your objective. For, in the final analysis, isn't our objective to contribute to the over-all success of the manufacturing enterprise by our part in promoting industrial health? We can do this best by making plant managers good management men by recognizing, on a practical scale, the benefits of good industrial hygiene. Industrial hygiene is good business, but it must be put on a business basis and sold on a business basis. It cannot be sold abstractly.

When you get to the supervision level, it seems that everyone is your ally, or best friend. This group is always looking for help, and almost always your help is appreciated. Anything you can do for them will be repaid. Supervision merely has to report back to the plant manager that you have aided in a problem and your position has been strengthened. Sometimes you may meet a little opposition, but the selling problem is much easier than with upper management levels.

Supervision, generally, will seek your help when it is in their province. Never discourage supervision, and always treat them properly. You never know when a supervisor will become a plant manager although it is often not difficult to pick out a supervisor of potential plant manager ability—sometimes by his attitude of managing in terms of people. Incidentally, many times the answer to your industrial

hygiene problem will be given to you by the supervisor who has lived with it and thought about it for days. We do not have to spend much time selling industrial hygiene at supervision level. Perhaps the only significance of selling at this level is that you are selling to representatives of the plant manager. Generally, just by doing a job, you sell to supervision.

I think we can summarize the attitudes of industrial hygiene thinking in relation to the three management levels—rather crudely, perhaps, but rather pointedly, and indicating where emphasis in selling should be applied.

Top management decides on an industrial hygiene program;

Plant management pays for the program;

Supervision uses it.

No matter how large or small your or-

ganization may be, someone has to take care of the health hazards. Even though the industry is not termed a "dangerous trade," there will be the ordinary run of problems such as acid handling, organic solvents, or toxic chemicals on a small scale. Radioactive isotope protection questions, potential fire or explosion hazards, stream or air pollution problems may occur. Comfort situations—heat or objectionable solvent concentrations—may exist. In instances such as these, the industrial hygienist has the training to improve conditions and can definitely contribute to plant operating efficiency. The problems are those that all levels of management must cope with. The need for industrial hygiene exists; the want is a bit obscure. When management is being educated to industrial hygiene, the only problem is "selling yourself."

Selling Industrial Hygiene to Management

— The Larger Industry —

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THE INDUSTRIAL hygienist called upon to face the problems of larger industries for the first time must adapt his thinking and activities to a number of new situations. Plants may be far flung geographically. Usually, each plant is operated on a decentralized basis, with the plant manager a king in his own domain. Frequently, the industrial hygienist is accepted first by the central group and it is up to him to sell himself to the individual plant managers. The hygienist probably will find considerable emphasis on channels of communication. Advice and services coming from unaccustomed directions will be disconcerting for a time to the individual operating units.

The industrial hygienist will find that specialization has been carried out to a remarkable degree. Many of the specialists, however, are particularly helpful to his activity. Locating these specialists and infiltrating their ranks so that all can work together is a challenge. Management has a

habit of setting a day of reckoning and the industrial hygienist like all other employees will one day be called on for an accounting. If this accounting is not satisfactory then there may be another, and different, industrial hygienist, or the activity may be suspended altogether.

Industry is dynamic! It grows; it changes; it is never static! Management will have been partially conditioned to the concept of industrial hygiene else it would not have hired an industrial hygienist in the first place. Nonetheless, if industrial hygiene is to fulfill its destiny it, too, must be dynamic and progressive. This means selling.

I have tried to list some suggestions that might be considered seriously if industrial hygiene in the larger company is going to be sold.

1. *Give Good Service.* If management is to be convinced of the value of industrial hygiene, then it must be able to turn to the record and find that it has been pro-

vided with a good product. The quality and quantity should be above reproach. Requests for services must have been handled promptly and efficiently. No amount of salesmanship can expand a market for a product of poor quality.

2. *Be Practical.* Business is conducted in an atmosphere of reality. Industrial hygiene pays out handsomely. We all recognize the fact and management will be convinced of it, too, if the case for industrial hygiene is presented along the lines that they have come to accept. In presenting industrial hygiene controls be sure that you have facts, documented, that substantiate your conclusions that something needs to be done. Keep your eye on costs. Management will weigh your recommendations against their cost and if you do some preliminary calculations in advance you will be in a better position to defend your case. If possible, offer those recommendations that represent the consensus of the parties concerned. Plant people know more about the process than you ever will. Work out your recommendations jointly with them. They will be more workable and, if the plant people have had a hand in preparing them, they will be less likely to object to putting them into effect. A few wild, impractical recommendations can do much to discredit industrial hygiene. You are going to have to live with your mistakes, so have just as few of them as possible. By all means keep things in their proper perspective. If you yell "wolf" in your handling of every problem, then management will have lost one of the most valuable things that you can bring to it—a professional appraisal of the seriousness of a problem.

3. *Advertise.* The old saying that a satisfied customer is the best advertisement is true of industrial hygiene. If you have done a good job and know that it is good, then you can plug for industrial hygiene by developing an analogy with the supervisor of the operation currently under study. He will check up on you, be sure of that. You can advertise in your reports. They should be comprehensive, scholarly, and summarized. The summary, succinct, preferably taking up no more than a page, is a good place to mention industrial hygiene. The people who will read the full

report are those with whom you have worked intimately and who know about industrial hygiene to a greater degree. Advertise also to those who will read only the summary.

Acknowledge those who have worked with you. The individual who gets his name in the newspaper is quite likely to get a few extra copies to distribute among his friends. The individual who receives an acknowledgment in your report is going to talk it up for you, is going to be an active disciple of industrial hygiene. An element of greatness is said to exist in the man who gives someone credit when he does not need to. Go ahead; treat yourself to an element of greatness.

Evangelize industrial hygiene. You believe in it or you would not be doing it. Pass along your convictions. Enthusiasm is infectious.

4. *Widen the Field of Application.* In making an industrial hygiene survey you would never dream of confining your interests to the production line alone. Find out where other areas lie in your company where industrial hygiene can apply and get to know the people that are responsible for these areas. Team up with them. Naturally you have a sales department. Who handles the servicing of its automotive equipment? A brochure is coming out on a new company product. Does it list information of industrial hygiene value? Are you familiar with all of the applications of your company's products? You can follow them through technical sales, and be in a position to work intelligently with your counterpart in the consuming industry. Are you following research and development activities intensively enough? Or the budgets? Each will give you a good idea of the problems that may be coming your way. Can the payroll department provide you with helpful information on the numbers of people involved in activities of industrial hygiene importance? Do you know the scope of the safety activities in the company so that you can implement their services and perhaps team up with them on problems of mutual concern? Do you know what is being done about process losses? It will make a lot of difference in your approach to atmospheric pollution. The more you get around in the company

the more applications of industrial hygiene you will find. As people know you and what you are trying to do, they will be bringing you problems.

5. *Be a Gentleman.* This is more than politeness. It encompasses your relationships with everyone with whom you work. It helps to avoid conflict. Confidence and trust will be given you, and it must not be betrayed. If you find that a particular activity has been badly engineered, it does not help to indulge in recriminations. Try to fix things up, without being patronizing, without being critical. After all, you will make mistakes, too, and will be needing a little charity. If your dire predictions have come to pass, avoid saying "I told you so." It solves nothing, and it is certainly likely to strike a note of disharmony.

The old joke about painting yourself into a corner is something to remember in industrial hygiene. A retreat need not mean defeat at all. It may be just a strategic withdrawal. It is a good idea to help the other fellow save face, too. He has been around longer than you, may be figuring that the company got along fine until you showed up, and can still dispense with your services without collapsing. Help him avoid getting into a position that will embarrass him later. He may not recognize or appreciate it, but it will make your work infinitely easier. After all, you are out to sell industrial hygiene, not force it upon someone.

Be a gentleman throughout—thoughtful, considerate, and helpful. Meet your opposition more than half way. Listen to the other fellow's troubles; they mean a lot to him. Try to understand his viewpoint and effect a solution that will be mutually desirable.

6. *Expand Your Circle of Acquaintances and Friends.* One of the immediate dividends that accrues is the setting up of direct, informal channels of communication. You can speak to someone personally, directly, off the record. The formality associated with the use of organizational channels can wait until you have worked out a mutually desirable approach to a problem. You will have set up an informational grapevine by means of which you learn a great deal that might never reach you or would at least be delayed in reaching

you if it followed normal channels. It provides an opportunity to educate company personnel in industrial hygiene thinking that will pay off handsomely at a later date.

That bright young student engineer may be in charge of the technical service department in a few years. The man currently in charge of maintenance operations may be the plant manager one of these days. The manufacturing coordinator may be a future member of the Board of Directors. If they have learned of industrial hygiene and have been sold on its value they will be selling your product for you and in areas within the company where your contacts might be infrequent. It is like the old apprentice system—get them young and raise them right.

Outside contacts are important, too. Inbreeding is not good. Are you civic-minded? Are you meeting people from other industries in an informal way? Do you have a schoolmate with whom you keep in touch and whose company has just developed a product that is exactly what is needed somewhere in your own company? Do you know your way around the industrial community and have a general idea of the more acute health problems? Look at the horizon occasionally; it will keep you from becoming near-sighted.

7. *Maintain Your Professional Stature.* The respect you will have and the credence that will be given your work will be in direct proportion to the amount you are paid, the position you occupy organizationally, the access you have to key people in the company, and the acceptance you have in your own profession. It is gratifying to see industrial hygiene salaries in industry reaching the levels that command respect. Industry has a quaint little habit of guarding the exact amount, but the word gets around of the general range, and your recommendations carry that much more weight. Naturally, however, you will try to earn that salary. If it is known that your position, organizationally, is high enough to command respect then you will get a more attentive audience. If you are in a position to present your case at high executive levels there is a reduced likelihood of indolence at the lower levels. If you have the respect of people in your own field, the same respect will be manifest

among those who recognize this fact and with whom you are dealing.

To achieve an earned professional stature it is well to be friendly and confident in your dealings throughout the company. If you are confident, you will be at ease. If you are at ease you will convey this feeling to those around you. Admit your ignorance but get the answer and don't get caught on the same one twice. If you get yourself out on a limb by bluffing, the competition will certainly enjoy the sport of sawing it off behind you. Never depart from your professional code of ethics. Making a mistake is one thing; compromising yourself professionally is another. Industry is paying you to tell them what it needs to know, not what it would like to hear.

8. *Explain Your Objectives and Approach.* The era of witchcraft is over. There is nothing mysterious about industrial hygiene, and it is sufficiently well established that you will gain materially by being forthright. Explain to the personnel department how its records are employed to develop occupational histories. Explain to the physicians how medical examinations and records can be of service to you. The process man will supply you with additional data if he knows you are interested in intermediates as well as the starting and final products, the things that go wrong as well as the usual plant events. Explain how you use hygienic standards, or weight the exposures for part-time jobs. Engineering control is easier if the people with whom you are working know why you want something done and what performance goal you are seeking. No one is going to take over your functions. Anyone trying will soon beat a hasty retreat when he finds himself in deep water. If someone can do some part of an activity

as well as or better than you and wants to do it—that is fine. That will leave you free to do something that he is incapable of doing. It is still your responsibility to integrate and coordinate the work. Giving due credit will not damage your position in the least.

9. *Keep in Balance.* Industry never hires a man and then tries to find something for him to do. It hires a man to do a needed job. Naturally you see what is needed in industrial hygiene but you will have to demonstrate that need, slowly and inexorably. For yourself you need a plan and a timetable which will need review from time to time to be sure that you are in balance and functioning optimally. If your work is all self-initiated or all requested, then you are not in balance. If your work is all opinion without adequate background data, then you are not in balance. If your reports are slow in getting out, or if a follow-up is not done after a suitable period of time, then it is well to see what can be done to achieve better balance. Perhaps the answer will be found in additional laboratory facilities, clerical services, or in your own failure to create a demand for industrial hygiene. Know where and how you spend your time, and sit down and review it occasionally to see if a slight reorientation might not improve your program. Grow, but grow slowly, in balance, and in the right direction.

SUMMARY: Industrial hygiene in industry is no more effective than its scope and the way in which it is received. Where the demand exists it must be enhanced, where it does not exist it must be initiated. It must be sold to management at every step. It is a continuous job and the opportunities are infinite.

The Spectrochemical Analysis of Air-Borne Dusts for Beryllium

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THE DEVELOPMENT of new industrial hygiene practices frequently involves the modification and refinement of techniques applicable in other scientific fields. Since work in this field depends on the analysis of trace quantities of toxic materials, the chemical methods used may be refinements of methods reported in the scientific literature as having other specific applications.

The spectrograph is finding greater use by industrial hygienists as another tool in the collection of toxicological data and the study of occupational exposures. The spectrochemical method described was developed at Oak Ridge National Laboratory¹ and has been specifically adapted to industrial hygiene problems involving dusts and fumes of beryllium and its compounds.

The toxicity of beryllium metal and its compounds is today well recognized.^{2,3} With the increasing use of these materials, especially in nuclear energy projects, the problem of safeguarding the health of workers has been given careful consideration. One aspect of this problem has been the desirability to determine quickly and accurately the concentration in air of these contaminants. To achieve this end, it appears that all installations concerned with this work employ some system of air monitoring and analysis. Some of the analytical schemes developed seem involved and prone to contamination during handling.⁴

At the NEPA Project in Oak Ridge, the over-all problem has been attacked in a manner which has permitted the interested groups to reach decisions regarding the protection of personnel engaged in handling beryllium. The spectrochemical procedure is derived from the porous cup technique developed at the Oak Ridge National Laboratory.¹ The general method is also used there for the analysis of beryllium in air samples.

Sampling

TWO MAIN TYPES of samples are prepared for spectrographic analysis. One type

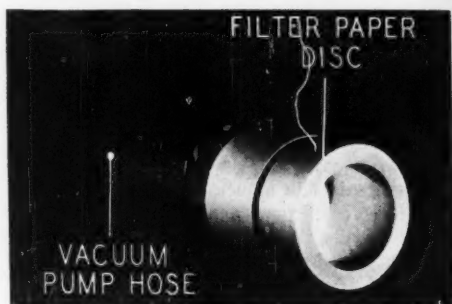


Fig. 1.
Air Filtration Sampling Head

of these "so-called" air samples is prepared by drawing a measured quantity of air through a one-inch diameter disc of Whatman No. 41 filter paper. The type of collector used to obtain these samples is shown in Fig. 1. The hose side of the sampling head is connected to a pump capable of drawing one-half cubic foot of air per minute through the filter disc. In use, the filter paper captures and retains the air-borne beryllium particles. A record is kept of the volume of air filtered, the time integral for sampling, and the location monitored. The filter paper with its dust is submitted to the spectrographic laboratory for analysis.

The second type of sample is also based upon dust collections from air but differs from the first in utilizing electrostatic precipitation rather than filtration. This type of sampling involves larger sizes of filter paper than that of the filtration technique and requires slightly modified chemical processing based on this fact. For this type of sample an electrostatic sampler Fig. 2, an instrument for electrically depositing dust particles from air streams drawn through it, is used to collect the sample. The device handles three cubic feet of air per minute.

The device is a commercial instrument modified at NEPA by the introduction of a sheet of filter paper formed to be closely concentric with the original collection elec-

*Now ANP Operation of General Electric Company.

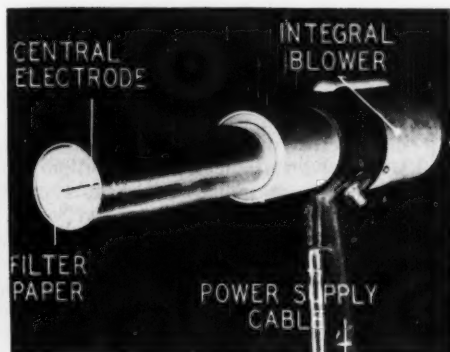


Fig. 2.
Electrostatic Sampler

trode. The filter paper gathers the sample and is easily removed for transfer to the spectrographic laboratory. It has been shown that the use of this paper collector results in less than 5% inefficiency at the 13.5 kv. employed.

A third type of sample is a deposited dust sample. These samples are usually obtained by wiping a contaminated surface with a small piece of filter paper. Information from this type of sample is not easily quantitatively correlatable, but it provides a practical measure of working hazard.

Samples are usually collected in duplicate. Temporary collecting stations are set up in regions suspected of being, or in danger of becoming, contaminated. Permanent collecting stations are placed in locations requiring constant monitoring, and several have been installed at points around the plant to permit long term monitoring of area atmosphere contamination.

Design studies have also begun on a direct-reading mobile analyzer for sampling the atmosphere of work areas under conditions in which immediate knowledge of concentration levels would be helpful. This analyzer would allow air from suspected areas to be pumped directly to gas transport electrodes⁵ and excited as the sample is being taken.

Spectrochemical Procedures

Two slightly different methods are used to obtain solutions representing the dusts retained on the dry filter paper. Both

of these methods assume that the amount of beryllium or beryllium compounds contained in a sample is small, and that the compounds will all dissolve when treated according to the described method. In cases when the Special Hazards Section of NEPA suspects that materials difficult to dissolve, such as high-fired BeO, are present the spectrochemical laboratories are informed of this and suitable changes in the general analytical procedure are made to assure solutioning of the specific samples.

In the first method, used with samples carried on one-inch filter discs, the papers were carefully folded in order to minimize loss during dry ignition. They were then placed in a porcelain crucible and cautiously ashed using an air-gas flame. The temperature of the flame was subsequently increased and the ash ignited. After ignition, the crucible was cooled and an addition of approximately 2 ml. of concentrated HCl was made. This solution was evaporated nearly to dryness and cooled.

This step, involving the HCl addition, is often omitted from the analytical scheme. It was included originally because of the ease with which beryllium metal dissolves in HCl, and because of the volatility of some of the chlorides of interfering elements, specifically FeCl_3 . The samples received for analysis have not, in many cases, needed this HCl treatment.

The next standard step of the procedure involved the addition of approximately 2.5 ml. of concentrated H_2SO_4 to the cooled crucible. This solution was fumed, on a hot plate, until reduced to a volume of about 0.5 ml. The beryllium was completely dissolved by this time.

The second method for dissolving samples utilized wet-ashing of the filter paper and residue. As before, the paper was folded and placed in a porcelain crucible, or in a beaker for samples carried on large filter papers. About 3 ml. of concentrated sulfuric acid was added and the mixture heated until the filter paper charred. After slight cooling, nitric acid was added dropwise until the charred filter paper was completely consumed. The solution was then fumed on a hot-plate until the volume was about 0.5 ml.

The solution, prepared using either of the above methods, was transferred to a

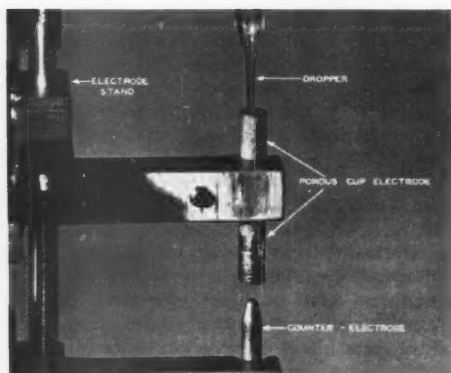


Fig. 3.
Filling Porous Cup Electrode for Excitation

5-ml. volumetric flask containing 100 μ of a 0.1% solution of molybdenum. The molybdenum represented the internal standard for the calculation of beryllium content. The concentration of molybdenum ion was 20 ppm when the total solution was diluted to the 5-ml. volume. The final solution for excitation was about 20% with respect to sulfuric acid. Samples known to contain large amounts of beryllium were handled in 10-ml. or larger flasks.

The solutions were excited in porous cup electrodes, Fig. 3, according to the method of Feldman. Electrical power was furnished by the high-voltage section of an ARL High Precision Source Unit with 60 volts to the primary of the high-voltage transformer. The sample was in the positive electrode of the polarized spark which crossed a 2-mm. gap. A short pre-spark was used to start the solution flowing through the electrode. An exposure time of three minutes was used. It has been found that a new power source designed specifically for porous electrode work, provides higher effective excitations of the solutions than the original ARL unit. This has permitted the use of one-minute exposure times for comparable spectra densities.

Spectra were photographed in the 2480 \AA —3700 \AA region available with a Baird 3-meter grating spectrograph. A 50 μ slit was employed. Spectra were recorded on SA-1 film which was processed under carefully controlled conditions in the conventional manner.

Standards and Calculations

ANALYTICAL curves were prepared, with standard solutions containing known amounts of beryllium and an internal standard concentration of 20 ppm molybdenum.

All spectra were photometered on an ARL film densitometer. Correction for background was made by subtraction of values related to the log. intensity values. To simplify this step the linear transmission scale in the densitometer employed was replaced by a composite scale bearing both the linear transmission scale and a scale incorporating the film calibration curve so that relative intensity values could be read directly.⁶ In the case of the beryllium and molybdenum lines in the 3131 \AA region this could be done with no loss of precision. Relative intensity ratios for analytical purposes were calculated for the following beryllium lines referred to the indicated molybdenum line:

Element	Line	Range (ppm)
Be	2650.781	5—0.5
Be	3131.072	0.5—0.05
Mo	3132.594	20

Discussion

THE precision of the method on duplicate samples is about 3.5%. This was specifically determined by the analysis of samples in duplicate. The over-all accuracy is difficult to determine, as it would require the examination of atmosphere containing known amounts of air-borne contamination. The limiting sensitivity of the method has not been determined since the limits dictated by the Special Hazards Section do not, as yet, approach present lower limits.

The results obtained at NEPA using this method appear to justify the continuance of the monitoring program. The work has been carried on for over a year and a half with resultant accumulating information concerning the safe handling and processing of beryllium and its compounds.

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Electric Gas Filter for Analytical Purposes

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ELECTRIC precipitators for dust sampling have been worked out and described by Drinker and Thomson,¹ Barnes and Penney² and others. The electric filter here delineated has been elaborated especially for facilitating the determination and chemical analysis of small amounts of substances, as aerosols. It has been used in a physiological investigation in connection with the use of aerosols carried out by Holmstedt³ at the Research Institute of National Defense.

Fig. 1 shows a diagrammatic section of the filter and Fig. 2 shows four filters mounted on a small high-tension apparatus, especially constructed for this purpose. Fig. 3 shows the rear side of the apparatus. The external parts 1, 2 and 3 (Fig. 1) of the filter are made of glass, and assembled by conical joints 4 and 5. The apparatus is easily taken disassembled for cleaning. The cylinder electrodes 6 and 7 may be made of thin silver or platinum sheet. The external electrode 6 is pressed tightly to the upper part of the joint 5, where it (at 12) is brought into electric contact with the platinum wire 8, melted into the glass and at-

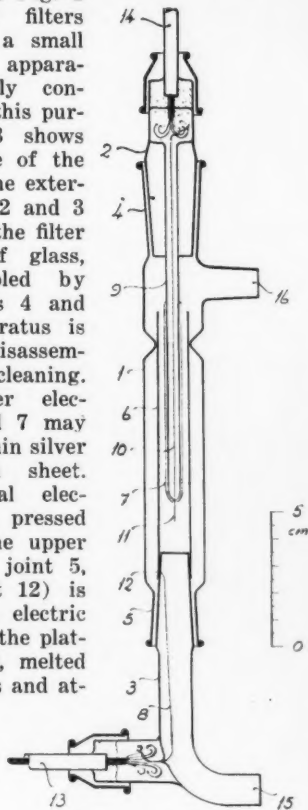


Fig. 1.

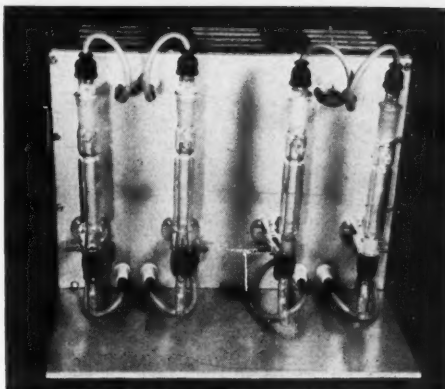


Fig. 2.

tached to the cable 13. The internal electrode 7 is supported by a glass tube sealed at the bottom and extending from the upper part 2. This tube is traversed by a platinum wire 10, which is at the top attached to the cable 14. The wire terminates at the bottom with a discharge point 11, which protrudes through a little hole in the lower, round part of the electrode 7. If the metallic contact between the wire and the cylinder 7 is bad, the cylinder is nevertheless sufficiently charged by dis-

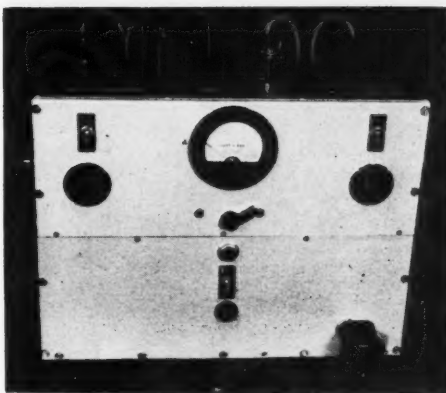


Fig. 3.

charge from the wire. The diameter of the platinum wire is 0.35 mm. The cylinder electrodes may be made from 0.10 or 0.05 mm. sheet. The cable 13 is connected to the positive pole of the high tension apparatus and cable 14 to the negative pole.

The aerosol, which is to be analyzed, is fed to the apparatus through the tube 15. By the corona discharge, which is generated at the point 11, the dispersed particles are negatively charged and they are subsequently precipitated on the electrode 6. (By reversed ionization a small precipitation can occur on the internal electrode 7, too.) The air liberated from aerosol leaves the apparatus through the tube 16.

The high-tension apparatus is built in the electric laboratory of the Institute and it is very compactly designed. It works according to a principle used in television apparatus. High alternate tensions are generated in a coil set, which operates as a high-frequency transformer. The output tension is rectified by a tube and flattened in the ordinary way. There are two different voltage circuits; each one designed to feed two gas filters in parallel. Each filter is connected in series with a resistor of 30 megohms.

The rectified tension is measured by an instrument provided with a two-way switch for connection to the one or other of the circuits. The maximum tension is 10 kilovolts when the filters are disconnected and about 7 kilovolts when the filters are in operation. The filters get active at about 4 kilovolts. In several cases 6 kilovolts proved to be the adequate operating voltage and the filters together with their resistors in series consume about 40-60 microamperes each.

The filter was primarily tested with aerosol of sebatic acid generated by a nebulizer according to Rooth.⁴ The nebulizer was run with an overpressure of 3 kg/cm² and before reaching the filter the aerosol had to pass through a bottle holding about 5 liters, where the main quantity of air

was admixed. The particle diameter for the main part probably was between a few tenths of a μ and one or a few μ . The air passing through the filter was tested by the Tyndall effect. The precipitation may be considered as complete up to a load of 1500 l/h. At 2000 l/h traces of aerosol were observed in the escaping air.

The filter can be used in different ways, so it is possible to flush or to dissolve the precipitated substances out of the filter for analytical treatment. For this purpose the small volume of the filter is advantageous because the precipitated substances are not unduly diluted. The substances may also be directly determined by taking out and weighing the cylinder electrode 6 (and possibly also the electrode 1). In this case it is important that the electric tension and the rate of gas flow are so adjusted as to cause precipitation only on the metal parts. This is to be checked carefully.

For checking the efficiency of the precipitation it may sometimes be advisable to connect two filters in series and to check the contents of both of them.

Attention should be paid to possible oxidizing caused by formation of ozone and nitrogen oxides and to the acidizing effect of the latter.

[The author wishes to express his gratitude to PROFESSOR G. LJUNGGREN for his kind interest in this work and for giving permission to publish this paper.]

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Determination of Free Silica by Dispersion Staining Microscopical Methods

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SINCE the publication of the "Dispersion Staining" method,¹⁻⁶ requests have been received as to its applicability to the microscopic identification of free silica in dusts and minerals. The method has been used in our laboratory for the determination of free silica in raw materials as a control of their purity. Free silica is commonly found in our abrasive corundum and to a larger extent in the red rouge (iron oxide) used as a polishing agent. Its presence in optical glass polishing materials of large particle size is very objectionable, and it must be removed by screening or other methods.

The same microscopical procedure as employed for our control work, with modifications, can be used for the identification of free silica in dusts. Two procedures are described, a dark-field and a phase microscope method. Both methods are similar in principle to that involved in the production of the Christiansen filter. Employing the dark-field method, if the difference in refractive index between the free silica particles and their immersion liquid is small, certain portions of their dispersion curves will approach coincidence and light of the corresponding wave lengths will be transmitted straight through or slightly refracted obliquely to the optic axis of the microscope and thus not enter the objective. The remaining light for which the free silica and immersion liquid differ to a greater extent in index is refracted and reflected into the objective. The eye thus sees the free silica as colored, the color being the result of the subtraction of the wave lengths passing straight through or slightly refracted from white light. Employing dark contrast phase microscopy, light for which the free silica particles and immersion liquid are equal in refractive index is undeviated by the free silica and as undiffracted light

is absorbed and reflected by the metallic absorbing film at the back focal plane of the objective. Light for which the free silica and mounting medium differ in refractive index on the other hand is deviated by the free silica and as diffracted light passes through the clear glass areas of the phase shifting element and is thus transmitted to the eyepiece of the microscope.

Dark-Field Method

PREPARATION OF SAMPLES: Two representative samples of the dust to be examined are placed on a clean slide. It is important for best results that both slides and cover-glasses used be optically clean. Washing in soap and water, followed by thorough rinsing in distilled water and drying with lens paper, has proved to be an effective method of cleaning. A drop or two of index liquid 1.544 (index of free silica for the ordinary ray) is placed on one sample and a cover glass applied. The same procedure using index liquid 1.553 (index of free silica for the extraordinary ray) is employed for the second sample. The index liquids are prepared by mixing in the correct proportion diethylene glycol monobutyl ether (Eastman Kodak Company) and cinnamaldehyde (Eastman Kodak Company). The amount of the lower index to be mixed with the higher to give the indices 1.544 and 1.553 can be approximately determined by the formula $V_1n_1 + V_2n_2 = V_3n_3$ where V represents the volume, n the index, and V_3n_3 the volume and index desired. Diethylene glycol monobutyl ether has a refractive index of approximately 1.429 at 25° C, and cinnamaldehyde an index of 1.619. Substituting these figures in the formula, a 10 ml. quantity of 1.544 index liquid would require 3.95 ml. of diethylene glycol monobutyl ether and 6.05 ml. of cinnamaldehyde, as shown in the computation given below.

This paper was presented at the 1951 Industrial Health Conference in Atlantic City on April 24, 1951.

$$1.429 V_1 + 1.619 V_2 = 10 \quad (1.544)$$

$$1.429 V_1 + 1.429 V_2 = 10 \quad (1.429)$$

$$0.190 V_2 = 1.15$$

$$V_2 = 6.05 \text{ ml.}$$

$$V_1 = 3.95 \text{ ml.}$$

A 10 ml. quantity of the 1.553 index liquid would require a mixture of 6.53 ml. of cinnamaldehyde and 3.47 ml. of diethylene glycol monobutyl ether. For accurate results the mixtures prepared should be checked on a refractometer for their exact indices. If slightly low in index, adjustment can be made by addition of a small amount of cinnamaldehyde or if slightly high by the addition of diethylene glycol monobutyl ether. The index liquids thus prepared should be rechecked occasionally as to their exact index since cinnamaldehyde tends to oxidize to cinnamic acid. This shift in index can be retarded by keeping the index liquid in a small bottle and maintaining it nearly full of the mixture.

Another method of sample preparation is by the addition of a wetting agent to the index liquids as suggested by Foster.⁷ This is of special value for dispersing quartz grains that are coated with kaolinite. Nuodex zinc 12%, a zinc naphthenate obtainable from Nuodex Products Company, Inc., of Elizabeth, New Jersey, is added to the immersion oils as approximately a 0.25% solution. As applied to the index liquids suggested in this paper, the total amount of Nuodex zinc should be dissolved in the diethylene glycol monobutyl ether and the correct amount of cinnamaldehyde then added to give the indices 1.544 and 1.553. Since the addition of Nuodex very slightly changes the index of the diethylene glycol monobutyl ether, the index liquids thus prepared should be checked on a refractometer. According to Foster's procedure, about twice as much of the sample is taken as would be used for a petrographic microscope slide; this is placed in a small boron carbide mortar, two drops of the index liquid containing Nuodex dissolved in it are added and the pestle revolved 200 times around in the mortar to grind the suspension properly. The pestle is used to put two drops of the suspension on a microscope slide, a cover is put over the drops and the slide is ready for examination.

Electric precipitator samples and impinger samples can be prepared for examination according to the dark-field illumination method suggested by Foster and Schrenk.⁸ Samples taken on cover glasses directly are ready for examination without any further preparation. Samples collected on celluloid or metal foil are prepared by scraping off a representative sample of dust and placing it on a microscope slide. Impinger samples of dust collected in alcohol are centrifuged so that the dust collects on a micro coverglass.

The samples thus prepared are examined by dark-field illumination employing an achromatic condenser of numerical aperture 0.59. This numerical aperture is obtained by removing the top element of the standard 1.40 N.A. condenser. For examination of the larger particle size samples, a 20X (10.25 mm.) 0.40 N.A. objective with anti-reflection coated lens gives beautiful results. This objective is a metallograph objective adjusted for a tube length of 215 mm. rather than for the 160 mm. tube length of the laboratory type microscope; however, this difference is not important as applied to observation of dispersion colors. Below the 0.59 N.A. achromatic condenser in the slotted ring is placed a dark-field stop having a diameter of exactly 17 mm. This size stop is not commercially available but can be readily made by cementing a circle of black cardboard, metal or plastic of the correct size to the center of the standard 16 mm. stop.

For examination of the smaller size particles a 43X (4 mm.) 0.65 N.A. or a 45X (4 mm.) 0.85 N.A. objective is employed. Anti-reflection coated lenses are not absolutely necessary but give slightly superior results. The numerical aperture of these objectives should be reduced by insertion of a funnel stop screwed into the objective far enough as to just touch the back lens. A funnel stop with an overall length of 1.092 inches and an aperture of 0.116 inches has been found satisfactory for most preparations. While no standard funnel stop is available, the stop designed for reducing the aperture of the 97X (1.8 mm.) objective can be used. If it should prove to be too long for the 43X (4 mm.) or the 45X (4 mm.) objective,

it can be shortened by cutting the aperture end from the stop, removing approximately 2 mm. of material and soldering or cementing the aperture to the shortened tube. The dark-field substage stop employed with the 43X or 45X objective is the standard stop, 16 mm. in diameter. If accurately centered, a 15 mm. stop can also be used resulting in a lighter background but slightly increased dispersion color brilliance.

A research microscope illuminator having a focusable condenser iris diaphragm and a 108-watt, 6-volt ribbon filament bulb is suggested as a light source. A daylight filter ground on one side can be used in the lamp filter rack when employing the 10.25 mm. objective but should not be used with the 4 mm. objectives since its use appreciably decreases the brilliance of the dispersion colors in the case of small particle size. In operation, the microscope illuminator without filter is focused on the *plano* side of the mirror and the microscope focused on the specimen. The substage iris diaphragm of the microscope and the lamp diaphragm are partially closed so as to reduce appreciably the amount of light. The substage condenser is then racked up or down as may be necessary to focus in the center of the field the image of the lamp iris diaphragm in the plane of the object. The back lens of the objective will now be filled with light of even intensity and an image of the lamp diaphragm can be found in the field of view whenever this diaphragm is sufficiently closed. The correct size dark-field stop can now be inserted, centered in the slotted ring below the condenser and the substage iris diaphragm opened to full aperture. The preparation should now be observed through the eyepiece and while viewing, the condenser slightly raised or lowered as may be necessary to result in the strongest coloration of the free silica particles. The illuminator diaphragm should now be adjusted so as to further increase the coloration. This step is very important as it prevents internal reflections which often cause a haze over the field. The accuracy of the dark-field method can be greatly increased by the additional use of polarized light. This form of illumination is most easily obtained by plac-

ing a cap analyzer over the eyepiece of the microscope.

Phase Microscope Method

A FURTHER check for the identification of free silica can be employed by the use of the phase contrast microscope. The method is essentially the same as that previously described⁹ for the identification of quartz. Samples prepared exactly in the same way as for the dark-field method are examined with dark-contrast phase objectives having accelerating annuli of one-quarter wave length. Critical illumination should be employed for best results and the substage condenser diaphragm image and phase accelerating annulus accurately centered. Employing phase objectives commercially available, brightest coloration of free silica particles was obtained with the 21X (8 mm.) 0.50 N.A. objective. Strength of color obtained with the 43X or 97X objectives was usually so weak that identification of free silica was difficult. As in the case of the dark-field method, preparations can first be examined with unpolarized light and then with polarized by placing a cap analyzer over the eyepiece of the microscope.

Results

FREE silica particles in the 1.544 index liquid as observed by the dark-field method and without use of the cap analyzer appear largely colored blue with a small amount of red. In the case of small particle size the amount of red evident is further decreased. In the 1.553 liquid particles are colored a pure blue. Employing polarized light (cap analyzer over the microscope eyepiece) particles in the 1.544 index liquid oriented for the 1.544 index are colored blue (in the case of large particle size a very small amount of red is also evident); particles oriented for the 1.553 index are colored red although large particles may also show a small amount of blue. Particles are identified as free silica that shift in color from predominantly blue to predominantly red or the reverse on rotating the cap analyzer 90°. Free silica in a 1.553 liquid oriented for that index and examined with polarized light appears a dark blue (in the case of large particle size a small amount of red is evident);

particles oriented for the 1.544 index are light blue. As in the case of the 1.544 index liquid, a shift in color from dark blue to light blue or the reverse can be obtained by rotating the cap analyzer 90°.

Employing the dark contrast phase microscope and unpolarized light free silica in a 1.544 liquid appears blue with an orange diffraction fringe. In the 1.553 liquid particles are colored a light blue usually with a dark red border. With polarized light (cap analyzer over the eyepiece) particles in a 1.544 liquid oriented for the 1.544 index are colored blue with a bright red diffraction fringe, particles oriented for the 1.553 index appearing blue with a yellow fringe. Particles are identified as free silica if their diffraction fringe shifts in color from red to yellow or the reverse on rotating the cap analyzer 90°. Free silica particles oriented for the 1.553 index in a 1.553 liquid are blue with a red diffraction fringe, particles oriented for the 1.544 appearing a light blue to white.

Occasional particles of free silica will be found dependent on their optical orientation that fail to show a shift in color on rotating the cap analyzer 90° or where their change in color does not conform exactly to the description given above. Agitation of the coverglass by means of a dissecting needle or similar instrument while observing through the microscope will result in reorientation of the particle on an optic axis such as to conform to the exact change in colors given above. In the case of small particle size, small enough as to exhibit Brownian movement, the switch in color from blue to red or the reverse in a 1.544 liquid can often be observed without agitation or rotating the cap analyzer 90°.

Using the dark-field method with either the 43 or 45X objectives with strict adherence to the method described, we have been able to identify free silica particles slightly less than one micron in size by their shift in color on rotation of the cap analyzer 90°. Results with the phase microscope appear to be somewhat dependent on the thickness of the metallic absorbing film at the back focal plane of the objective. Employing a specially prepared 97X (1.8 mm.) 1.25 N.A. objective having a transmission of 3.5%, we have

identified free silica particles as small as two microns.

Results can be made quantitative to the nearest 10% by the methods reviewed in Chamot and Mason.¹⁰ This estimate is based on the fact that free silica particles when properly oriented conform to the color description given above, while particles not free silica appear white or if colored fail to show the typical shift in color on rotating the cap analyzer. Increased accuracy and ease of enumeration can be obtained by the use of a Whipple disk in the eyepiece of the microscope according to the method of Ross and Sehl.¹¹ Employing this method, particles are counted and assigned relative weights dependent on their size as compared to the size of the squares of the Whipple disk. Since the density of quartz is 2.65 and that of the common minerals is mainly 2.5 to 3.0, the value obtained may be accepted as the percentage by weight.

As to the accuracy of the methods described for distinguishing between free silica and minerals of very similar index and birefringence, further investigation will be necessary. It is believed that the suggested use of accurately prepared index liquids equal to free silica for both the ordinary and extraordinary ray and examination with both unpolarized and polarized light should appreciably increase the accuracy of microscopical methods.

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The Meteorological Aspects of Air Pollution

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METEOROLOGY is important in the study of community air pollution for only through varying weather conditions can air-borne contaminants be reduced to negligible levels. Meteorology, however, is only one factor controlling air pollution, the other principal ones being: (1) topography, which modifies the influence of weather; and (2) the source of pollution itself.

The natural control of air pollution involves dilution and it is only where man or nature has created excessive pollution that this cannot be accomplished. Air pollution from natural sources is uncontrollable and often violent, some common examples being volcanoes, forest fires, sea salt-spray, swamp odors, etc. However, it is the air pollution by man that is increasing and should be controlled. One need only to consider our expanding industries, such as chemical plants, and our increasing city motor traffic to defend this stand.

Chronic and Acute Air Pollution Problems

THE severity of air pollution is usually determined by weather and topography. We have, on the one hand, acute conditions of air pollution, the best examples being the smog incidents of Donora, Pennsylvania, and the Meuse Valley in Belgium. In both cases the pollution of the air became so concentrated that the effects were catastrophic to communities involved.

In contrast to this, many of our industries are unfavorably located, a fact which creates conditions of chronic air pollution when periodic changes in the wind and weather accentuate the normal industrial air contaminants. The effects are not so dramatic or so dangerous as found with acute air pollution, but often are accepted as daily nuisances in industrial areas.

The classic example of large-scale chronic air pollution was a smelter at Trail, British Columbia, where sulphur dioxide fumes affecting crops in the State of Washington resulted in international litigation.¹ A sub-

sequent intensive investigation was made, much of it of a meteorological nature. Another large scale example of chronic air pollution is the smog situation at Los Angeles, California.^{2c} This also has been extensively investigated, and as a result the Stanford Research Institute has developed a "smog index" to forecast the occurrence of smog.

It is important to note the change in public attitude concerning air pollution. Where in the past periodic undesirable smoke and fumes were accepted in thriving industrial communities, now such conditions no longer are accepted. The inference is clear. Offending industries should examine their sources of industrial waste and the meteorological mechanism of its disposal before an aroused and misinformed public reacts unfavorably.

Certainly the importance of a possible public health hazard must not be overlooked in these cases of chronic air pollution. Much work is yet to be done, but no study would be complete if it omits the meteorological aspects of air pollution.

Meteorological Fundamentals and Terminology

THE process of natural dilution depends almost entirely on air movement, which in the free atmosphere, is quite complex. By the use of theoretical considerations and experimentally-observed results of artificially-generated smokes from towers and in wind tunnels, valuable data have been obtained. Air-borne effluents leaving a source become entrained at the time of release in the mass of air passing the source. The size and motion of the air mass varies according to meteorological and topographical factors prevalent. Where motion is slow and constant both in direction and speed, dilution and mixing are at a minimum; where motion is faster, random and irregular dilution and mixing are greatest. Dilution by this irregular motion is known as eddy diffusion or turbulent mixing and is very large compared

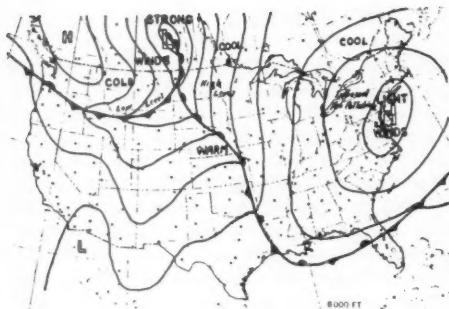


Fig. 1.

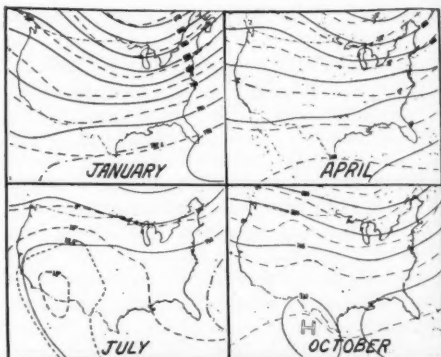
Hypothetical example of a weather map showing effect of large scale weather systems on air pollution.

with molecular diffusion which is minor or negligible.

While the wind accounts for carrying pollutants many miles from their source it is the unapparent vertical flow that is of major importance in the dilution of air-borne waste, since most sources of industrial pollution are above ground level and only through some vertical flow will it reach the ground. Horizontal and vertical flow are so interrelated that the forces which create them modify each other.

It is important for the safety engineer or industrial hygienist to realize that the solution of a specific industrial pollution problem most always will require objective measuring both of contaminants and weather conditions unless the solution be a straightforward elimination of the pollution source.

In Fig. 1 is an idealized example of a weather map of the United States showing the general relationship between changing weather conditions and air pollution. East of the Mississippi River is a high-pressure area or anticyclone which is usually associated with good weather but which also has the greater possibility for widespread, sustained air pollution, especially when such an area stagnates over an industrial region for a several-day period, as in the Donora episode. The high pressure type most likely to stagnate is known as a "dynamic" high, where the pressure is relatively higher at each level for some distance up in the atmosphere. Just why a polar anticyclone should stagnate for



NORMAL PRESSURE CHARTS AT 10,000 FT LEVEL

Fig. 2.

Normal pressure charts at 10,000 feet level showing seasonal effect of upper air flow on air pollution.

more than one or two days is explained by Wexler, et al, in the U.S. Public Health report on the Donora smog episode.⁴

Shown also is a typical frontal system or low-pressure area, usually associated with unfavorable weather but with decreased air pollution mainly because of the stronger winds. The United States geographically is subject to a large-scale eddy exchange between the cold northern regions and the warm southern regions. This results in a constant formation and movement of frontal and air mass systems, traveling generally from west through east. A frontal system is that boundary region between dissimilar air masses, and is so designated cold or warm according to which mass of air is actively displacing the opposing air mass.

Willet, considering air pollution probability, has examined the seasonal variations in the upper air flow.³ Fig. 2 shows normal pressure patterns at the 10,000-foot level for the months of January, April, July, and October. While these are isobars or lines of equal pressure, they can be interpreted also as stream lines of air flow. The closer the isobars are grouped, the stronger the average wind flow and the faster the surface pressure systems move. The contrast of the closely packed stream lines in January with the more divergent lines in July, shows that the average upper-air wind speed in January is appreciably

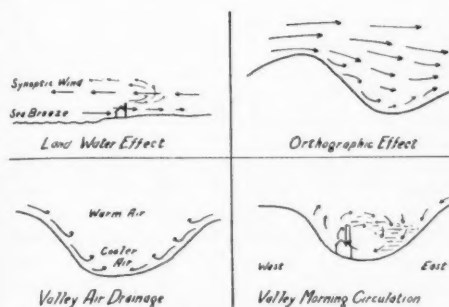


Fig. 3.

Topographical modification of localized air flow distributing air pollution.

faster than the upper-air wind speed in July. In the fall and spring seasons (April and October) the stream lines are midway between the winter and summer conditions. Were pollution dependent only on upper-air flow, then the summertime might be expected as the maximum. However, during the summer, vertical currents due to increased daytime surface heating, minimize any large-scale air pollution. Air pollution builds up best in the spring and especially in the fall because the combined factors of faster upper-wind flow and large daytime convection heating are minimized. Also note the all-year contrast between the well-established industrial northeast and the newly-created industrial southwestern coastal area. This explains in part California's desirable weather but undesirable air pollution.

Fig. 3 shows how localized topography modifies the weather and may increase air pollution. This is pertinent, as Hebley has shown most of our industrial areas to be located in valleys or basins on rivers or lakes.^{5A} A land-water effect results where a sea breeze or its reverse, a land breeze, occurs in a very shallow layer of a thousand feet high or less and extends inland only a few miles or less and is independent of the regular, or prevailing pressure system wind above. The result is that pollution released in the lower layer may be carried in one direction and be carried in another direction at a higher level.^{5B}

Where wind flows at or near a right angle to the axis of a hill or mountain it has an effect of slowing down in the very

lower levels and may also cause some turbulence which distributes air pollution. A third effect is radiation-cooling at hilltop level that occurs on clear cool nights with light winds and causes air drainage into the valley bottom where it forms a sluggish stream of relatively cooler air capped by warmer air. Thus, drainage currents are very important in collecting, spreading, and mixing industrial air pollution in valley sites. Fog often forms in this cooler air and may persist throughout the day or longer because a very dense fog layer has high reflecting qualities and so resists the sun's heat.

A fourth modification occurs when the early morning sun's heat on one side of a valley sets up a weak cross-section circulation which may bring down, from mid-valley level to the ground, industrial pollution that has collected during the night.¹

Atmospheric measurements throughout the vertical are necessary as weather is a three-dimensional phenomenon. Basically this involves: (1) air pressure, which decreases with increasing altitude; (2) humidity, quite variable at all altitudes; and (3) temperature, also variable between limits but normally decreasing with increasing height. This temperature-height relationship, often erratic in the lower levels, is called a lapse rate or free-air curve and is plotted twice daily from data collected by free balloon-borne radio transmitting instruments (radiosonde). The free-air curve identifies the air mass overhead and the temperature and humidity changes in the upper atmosphere. It is not uncommon for various layers of the atmosphere to show a temperature increase with height. This is known as a temperature inversion.

One atmospheric phenomenon which an examination of upper-air soundings will reveal is subsidence which may be considered as the sinking and spreading out of a large mass of air in a high-pressure system. The slowly sinking air is thermodynamically heated, creating a stratum of air warmer than the air usually found at that level if the lapse rate were normal. With marked subsidence, a temperature inversion is usually formed.

In Fig. 4 are shown free-air curves observed at Pittsburgh for the period Octo-

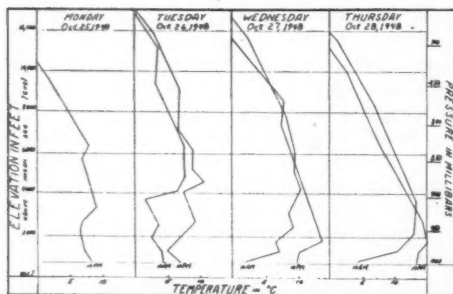


Fig. 4.

Series of free air curves (Radiosonde) for Pittsburgh with extension of Donora surface temperatures for period October 25-28, 1948.

ber 25 through October 28, 1948 (the Donora smog episode). Except for the surface temperature these were taken from the thermograph record at Donora.⁶ A good example of an erratic free-air curve is shown on October 26 and a good example of subsidence is shown on October 28. Note the temperature inversion below the subsiding layer in the morning free-air curves on October 27 and 28. This combination of subsidence-ground inversion acted as a "lid" to pollutants released within the inversion layer and prevented normal vertical dilution.

Most weather phenomena depend on the stability or instability of the air masses. This concept of stability may be considered as a measure of the resistance to vertical motion within the free atmosphere and is important in air pollution, for it is indicative of the degree of vertical diffusion. Stable air resists vertical motion; unstable air assists it. A simple measure of the amount of stability is the slope of the free-air temperature curve compared with the critical slope which is shown graphically in Fig. 5. Meteorologists use charts that have as a background these critical sloping lines with which to judge the slope of the free-air curve of a particular layer of air. The slope of this line is the rate of adiabatic temperature change, which for dry air is approximately 5.5° F per 1000 feet. As shown in Fig. 5, a layer of air is stable if the temperature lapse rate is less than the dry adiabatic rate and is unstable if it is more than the dry adiabatic rate. The atmosphere is normally stable, and charac-

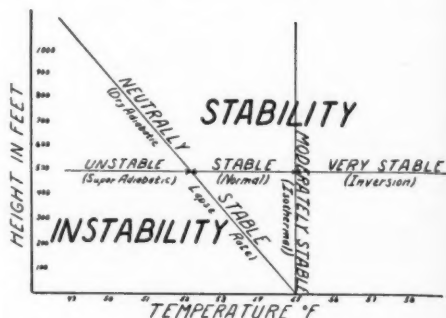
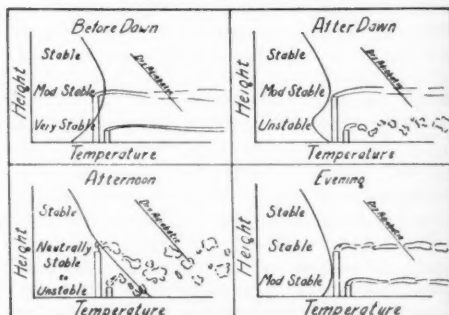


Fig. 5.

Graphical representation of stability and instability in the atmosphere according to the slope of the free air temperature-height curves.



DAILY CHANGE IN STABILITY

Fig. 6.

Schematic diagram showing typical daily changes in the free air curve and the resulting effect on air-borne waste disposal.

terized by a temperature lapse between 5.5° F per thousand feet and no decrease in temperature. If the free-air curve does not lapse but increases with height (inversion) the air is very stable. The conditions just explained apply only to dry or partially dry air and are slightly changed if the air is saturated with moisture. The comparative slope is the saturated adiabatic lapse rate, a variable value less than the dry adiabatic lapse rate. The above explanation of stability is over simplified but it should be sufficient to inform the engineer of the importance of vertical distribution of temperature in the atmosphere.

Fig. 6 shows a schematic diagram of the normal daily changes of the free-air curve. Before dawn the lowermost layer of the air

is normally cooler than the air above it (ground inversion). This resulted from conductive cooling as the earth's surface lost heat by radiation during the night. After dawn the sun begins to heat the surface, which heats the air immediately adjacent to it; thus quickly inducing convection currents which warm the layers still further above. By afternoon the sun's heating has created a strong lapse, distributing pollution throughout the convection layer and causing greater effective dilution due to increased air volume of the convection layer and larger sizes of the eddies. After sunset, surface cooling in the lowermost layers of the atmosphere creates an inversion at the surface which is strengthened and extends upward throughout the night as the cooling continues. In convection the effluent does not produce a static pattern but a random motion, mostly in the vertical which brings near to ground level at various distances from the stack a concentrated portion of the effluent for a short duration of time.¹² In the very stable conditions of an inversion, the effluent generally travels horizontally. The inversion-to-lapse change is quite noticeable on a clear sunny morning with a light wind when convection currents reach the effluent source. This figure shows only the effect of cooling during the periods of light winds. Low clouds, strong winds, or the horizontal movement of warmer or colder air into the area, will modify this daily heating and cooling phenomenon.

Meteorological Measurements Used in Air Pollution Studies

INDUSTRIAL hygiene engineers interested in air pollution should be acquainted with the meteorological measurements used in air pollution studies. The simplest consideration involves a statistical approach, or the use of climatology. Much of the average and extreme values of temperature, wind, and rainfall in continental United States can easily be obtained. Use of the daily weather map and forecasts, daily winds aloft, and upper-air temperature observations can also be helpful in estimating expected industrial pollution. These data, both observed and forecast, are readily available from any U.S. Weather Bureau office, but they are only of a general na-

ture. This has led some industrial establishments to hire meteorologists or seek meteorological consultation pertinent to their needs.

For a direct approach to understanding the meteorological mechanism of a specific case of industrial pollution, a micro-meteorological study of the area should be made. This is generally a more intensive study of the weather over a relatively small area such as the site of an industrial area, or the limits of a city, etc. Most important is the measurement of the wind, preferably recorded rather than just observed. The irregularity of wind flow, or gustiness, more difficult to measure than simple speed and direction, is very important since it is a measure of the turbulent diffusion of the atmosphere. Hewson reports on specialized instruments developed in the Trail investigation, one being the bridled-cup turbulence integrator which shows changes in wind speed resulting from gustiness.¹

Measurement of the free-air temperature is equally important and, while not readily available, values throughout the first several hundred feet of the atmosphere are extremely useful. The method used in most permanent studies involves the erection of meteorological towers with instruments at critical levels, and the notation of temperatures by means of ventilated electrical recording thermometers.

Micro-climatological measurements should be recorded for at least a year to be of real value. Added years of observation correlated with pollution source and air concentration data should definitely establish the meteorological aspects of an air pollution problem; however, such would probably not be undertaken unless control of the problem were principally meteorological.

Resume of Meteorological Findings

IT IS beyond the scope of this paper to do little more than refer to the progress both in theoretical treatment and in experimental observation made toward understanding the weather factors involved in air pollution. The theoretical treatment that forms the basis of most of today's air pollution engineering resulted from the work of English investigators, but experimental observation best known in this

country has been fostered research of the Atomic Energy Commission and investigations of Donora, Trail, and Los Angeles.

In 1936, Bosanquet and Pearson published a mathematical treatment for calculating the speed of smoke from chimneys.⁷ They developed methods showing concentrations (ground level) expected at various distances downwind, using data of height and mass-rate-emission of a source. They postulated that maximum concentration would be at a distance of about 10 stack heights, with small concentrations near the base, and, after the distance of 50 stack heights, the concentration would vary as the inverse square of the distance and be independent of the stack height. There was reasonable agreement between computation and observation under normal weather conditions but not under conditions of temperature inversion. However, Gosline has stated that more appropriate values of the diffusion coefficient used in the Bosanquet and Pearson formula will give satisfactory results over wider ranges of weather.^{8,9}

Somewhat later, Sutton published an article dealing with the same problem and he developed a formula for the concentration of the pollutant in space windward from the stack.¹⁰ Sutton used diffusion coefficients defined in terms of the eddy velocities in the vertical and cross wind, the kinematic viscosity of the air and n , a pure number lying between zero and 1. The latter is a parameter related to the diffusing power of the atmospheric turbulence which Sutton further states approaches zero in very turbulent air and approaches unity in conditions of low turbulence. American investigators, such as Thomas and associates, and others have successfully used these formulae by adapting them to their own problems.²³

More recently Sutton has dealt with theoretical considerations of the dispersion of hot gases in the atmosphere from a point source, where he shows that the reduction of maximum concentration of the effluent at ground level can be effected by adding heat to the effluent. The reduction is directly proportional to the strength of the heat source and inversely proportional to the height of the source (chimney) and the cube of the horizontal wind speed.

Excellent progress has been made in experimental observation of stack effluents, by coordinating much of the maximum and average concentration of pollutants at various distances from the sources with changing weather conditions. In studies made at the Hanford works of the Atomic Energy Commission, Church observed smoke plumes coordinated with measurements of the oil smoke in-air concentration at various distances from the sources and under measured conditions of vertical temperature gradients and wind speeds. Smoke density was measured photo-electrically by air sampling downwind from the source. Three basic types of plume movement were named: "Looping, coning, and fanning." "Looping" occurred in large-scale eddies when wind speed was less than 20 miles an hour and the air unstable, with smoke reaching ground level comparatively close to the stack and diluted with as little as 300 volumes of air. "Coning" occurred when the eddies were smaller and developed by turbulence, usually due to ground roughness, with wind speeds in excess of 20 miles per hour and the lapse rate normal. The maximum concentration usually occurred from eight to 10 stack heights downwind. "Fanning" occurred under light winds where the vertical temperature distribution was isothermal or inverted, in which case the smoke plume traveled horizontally downwind with very little vertical displacement and with concentrations remaining high within the plume to quite some distance. These observations were made over relatively flat ground and would certainly be modified over a hilly terrain.

Observation of smoke plumes has also been coordinated with meteorological measurements at the Brookhaven National Laboratory where Smith and Lowery have described four types of gustiness shown by a recording wind vane on a meteorological tower.^{14,17} With each type there is a recognized pattern of the amplitude of change in wind direction. This method of estimating turbulent diffusion along with other forecasted meteorological data has been used to calculate average concentrations expected windward from the pollution source.

Unfortunately, the available formulae for calculating average concentrations include

coefficients which vary with changing weather conditions such that the choice of values used is a matter of judgment of observed or expected meteorological parameters. Since pollution is primarily diffused by eddies, this may make the average concentration of minor importance, for the frequency of the partially-diluted pollutants in the eddy that pass through a given point, and the limits of dilution within the eddy are of greater importance. Gosline differentiates between these significant concentrations as: (1) time average concentration at a point over a period of hours; (2) time average concentration during eddy pollution, a matter of minutes or less; and, (3) the maximum concentration experienced during eddy pollution, a matter of seconds.⁹ Gosline further states that observed concentration values should be treated in some sort of a statistical manner, a procedure quite practical if measurements are made with recording instruments. The advantage of considering the problem of peak concentration and of eddy frequency and duration in an air pollution study is apparent, especially in health and nuisance complaints.

While much study has been made of specific sources of air-borne effluents, there is still further need to study the effects and the meteorological mechanism of widespread air pollution from multiple sources such as found within an industrial area. As governmental and air pollution control units become more numerous and better organized, increasing study of our city air pollution problems will be made.

In England some investigation of this type has been published. In the industrial city of Leicester a study of community air pollution was made coordinating concentrations of smoke, dust, soot-fall, sulphur dioxide, and reduction of daylight with measurements of weather conditions.^{15,17} One of the principal findings was that pollution spreads out from city sources but not as fast as one might expect from the wind flow. This, then, indicates that much of the pollution was spread by vertical displacement.

In our own country, the U.S. Public Health Service studied air pollution in Donora following the unfortunate smog incident.⁴ By coordinating pollution and

meteorological measurements data were obtained to explain the pollution distribution within the area. The principal significant meteorological finding showed that the presence of either thermally stable conditions or stagnating high-pressure systems alone were not enough to create high air pollution. Rather, the combination of a high degree of stability and stagnation is believed necessary for the accumulation of air-borne pollution and the meteorological type most likely to cause such is indicated. Also, a set of critical meteorological values that persist for one day with no forecasted improvement is given as a part of any program to be followed in preventing a recurrence of the Donora tragedy.

Within recent years other techniques and observations have been applied to the meteorological aspects of air pollution studies, often as a part of large-scale investigations, other times as a part of investigations in related fields. One such example is the work of Steffans and Rubin on the correlation of visibility and air pollution by the measurement of the attenuation coefficient at different wave lengths using photographic density comparisons.^{2A,5C} Their purpose was to obtain knowledge of the physical properties of the suspended particles found in Los Angeles smog.

Neuberger and Gutnick have made studies of condensation nuclei with respect to fog and air pollution.^{5D} They counted condensation nuclei with a modified Aitken-Ludeling counter and measured the intensity of laboratory-created fog by a light transmission method. They found that a higher count of condensation nuclei (equivalent to increased air pollution) produced smaller water droplets and increased fog persistence, but did not appreciably increase fog density when comparing equivalent nuclei counts of moderately-polluted air (small towns) to highly-polluted air (heavy industrial towns). In research by Shaefer and Vounegut on condensation nuclei in the free atmosphere, a continuous-recording nuclei counter was developed,^{5E} which was essentially a photo-electric recorder of a small illuminated cloud chamber where cycled pressure variations produce and dissipate a cloud of water droplets from humidified air intake of the atmosphere measured.

Other devices aiding in air pollution studies are the use of "kytoons" and "wire-sonde." "Kytoons" are essentially small gas-filled plastic balloons controlled from the ground. Using them, meteorological instruments (or air sampling instruments) may be carried aloft several hundred feet. "Wiresonde" is similar to radiosonde in principle but is used to record on the ground meteorological measurements taken aloft. It employs a special light-weight cable and electrical conductor.

Wind tunnel observations of models of industrial plants contribute to the knowledge of industrial air pollution control methods. From such studies of both the aerodynamic phase (jet dispersion) and meteorological phase (plume dispersion), valuable data may be gained to determine optimum specifications for proposed stacks.

The Present Problem

THERE are today many industries that are well aware of the air pollution problems they have helped to create and, realizing their responsibility to the community and the value of good public relations, they want to do something about it. Unfortunately, any meteorological planning or control is too often accepted as academic rather than as a practical matter. Meteorology may be used in some industries for the daily control of chronic pollution. Under adverse conditions, either observed or forecast, production might be curbed. If this is unfeasible, and for most industries it usually is, better air-borne waste disposal might be accomplished through the use of added heat or ventilation. These controls, if used continually, might be uneconomical yet perfectly feasible during intermittent periods of weather unfavorable for normal means of air-borne waste disposal.

Industrial planning can well use meteorology in the selection of plant sites, and waste disposal design for such consideration is capable of an economic evaluation. Meteorological consideration may even be used in plant layout; for example, a simple study of the prevailing winds might better locate laboratories (with their attending odors) in relation to business offices.

An informed industry will help the general problem of abating air pollution. Pri-

marily, management should realize that applied meteorology in waste disposal engineering is practical. Second, industry can cooperate in obtaining climatological observations and auxiliary meteorological measurements pertinent to air pollution. For example, continuous reports of wind and temperature from instruments properly installed on such elevated positions as water and radio towers would give meteorologists a better picture of the smoke diffusion layer over the city.

As a means of evaluating the present status and future needs in abating air pollution in this country, one might consider the principal recommendations of the Meteorological Panel, U.S. Technical Conference on Air Pollution, as outlined by Hewson.¹⁶ First, there is a need for instrumental standardization of meteorological measurements in air pollution studies. Second, the theoretical study of diffusion of gases and particulate matter in the lower layers of the atmosphere should be encouraged. Third, it is proposed that extensive studies of air pollution of our cities be made. This program should be long-term and nation-wide with the work done at local levels. Competent meteorologists should be employed to coordinate continuous records of pollution concentrations with meteorological measurements. Fourth, it is recommended that more measurements be made by the U.S. Weather Bureau specifically to aid in the study and control of industrial air pollution. Fifth, it is believed that there is a definite need for better organization of the literature and dissemination of information about air pollution.

In conclusion there is a need for better meteorological parameters with which to judge the severity of possible air pollution and to aid in its abatement. While measurements in the vertical have been made at selected sites for air pollution studies, the real need is to be able to specify the effects of air pollution from weather data ordinarily available to the practicing meteorologist.

Summary

METEOROLOGY is a practical factor in any air pollution study, for it can aid in abating chronic air pollution problems and

may prevent these problems from becoming acute.

To do this, industrial hygienists should have a fundamental understanding of: (1) air movement in the free atmosphere; (2) common topographical modifications of weather; (3) the use of meteorological methods needed to measure the temperature gradient and the turbulence characteristics of wind throughout the pollution diffusion layer; and (4) measurement of meteorological significant concentrations of pollution.

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Recirculation of Cleaned Air from Cast Iron Machining

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THE requirements for a suitable dust collector to be used on cast iron machining are best explained by studying the nature of cast iron itself. When cast iron is poured and allowed to cool without annealing, soluble carbon in the molten iron precipitates, giving cast iron its greyish color. When cast iron is machined, the precipitated carbon, as graphite, acts as a discontinuous barrier so that chips come off in the form of fine granules instead of long spirals as in the machining of steel. This characteristic of cast iron also allows much machining to be done without using a coolant.

From this explanation it can be seen that in the machining of cast iron there are two distinct products. The first product is a mass of fine granular chips varying in size from one-quarter inch down to a few microns. This is more than 98% by weight of all the material generated. The other product is a graphitic carbon dust, all of it less than 40 microns in size, and most of it less than 10 microns. It is this graphitic dust which is the nuisance material. Where it is allowed to escape into the atmosphere, it makes machining operations unpleasant by making operators feel and look grimy after a short time at work. The whole working area quickly becomes a dismal and depressing grey, even with good housekeeping. A sewing machine company in Ohio recently moved into a new building where the interior was painted in pastel colors. The cast iron machining department adjacent areas were painted a light blue. After less than three months of operation without local exhaust ventilation, the blue in the cast iron machining department had turned to a dirty grey, while in other departments the paint still had a new look.

The iron dust which gets into the air does not constitute as unpleasant a nuisance as the carbon. It does settle on machinery and thus require additional housekeeping. In addition, in cold climates it is likely to

attach itself to moisture on windows, oxidize, and produce a brown film which is difficult to remove.

Local Exhaust Ventilation

BY THE use of local exhaust ventilation on cast iron machining operations it is possible to prevent the graphite dust from escaping into the working area. It is also practical to collect the cast iron dust and lighter fraction of chips. Both dust control and complete chip disposal can be designed into one system, but experience indicates it is easier to let heavy chips be picked up manually or mechanically than to have them picked up by the exhaust system.

It is not necessary to have a high capture velocity at the point of dust generation. The dust which is to be removed by the exhaust system is not released with high initial velocity and merely tends to become air-borne. As a result, low indraft through hood openings, creating general ventilation of the area where the dust is generated,

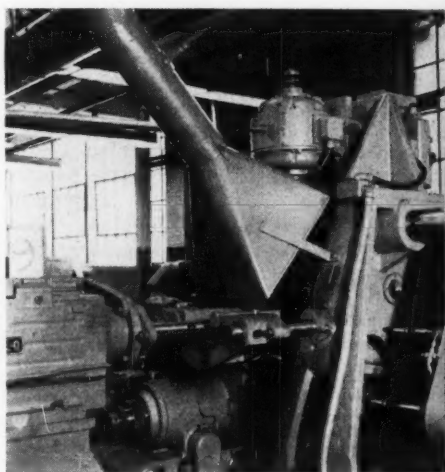


Fig. 1.
Ex-Cello Drill for drilling, countersinking and reaming is exhausted by one 6-in. branch (900 cfm).

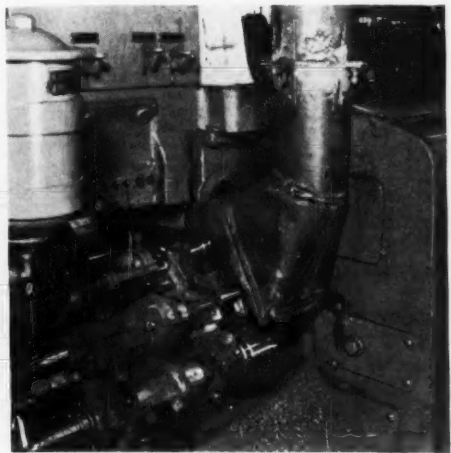


Fig. 2.

A No. 60 six-spindle New Britain Screw Machine has one 4-in. branch (400 cfm). Note the pile of chips below hood.

will pick up this material and prevent its spread into the general working area. Typical hoods for cast iron machining are shown in Figs. 1, 2 and 3.

Note that the closer a hood is to an operation the more cast iron chips it will pick up. However, large chips do not constitute the nuisance material, and close-

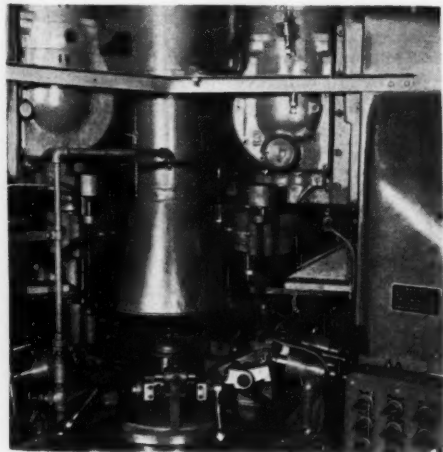


Fig. 3.

The Kingsbury 20-in. Automatic Index Drill uses one 8-in. branch (1600 cfm).

fitting hoods are not necessary to get effective control.

Dust Collecting Equipment

IN LATE 1945 American Air Filter Company was first requested to investigate the problem of designing a suitable dust collector for cast iron machining by an Indiana aircraft engine company. Wet collection was not desired because of water supply and drainage problems as well as a desire to avoid handling high density sludge from a wet collector. Fabric collectors were ruled out because of space requirements.

The nature of the material to be collected indicated the need for a two-phase collecting assembly. In the first phase all of the heavy material would be removed. In the second phase, all of the fine fraction escaping Phase 1 would have to be collected. Because this second fraction consisted principally of very fine graphite dust it would have to be removed with a high degree of efficiency. This high collection efficiency would be necessary despite the fact that

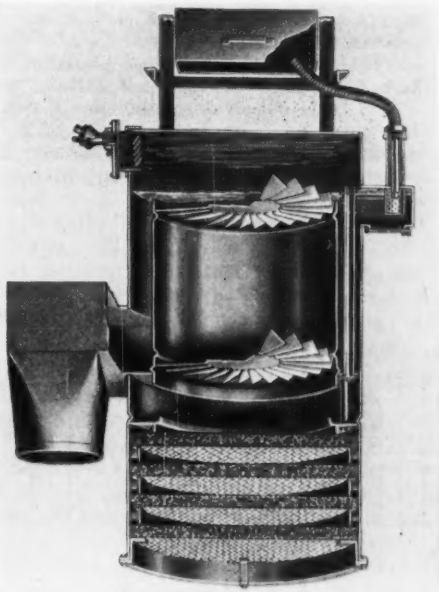


Fig. 4.

Cutaway view of TO-8 Cycoil Oil Bath Air Cleaner.

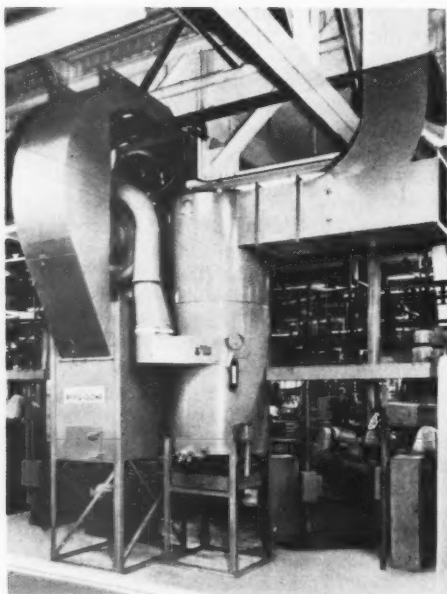


Fig. 5.

This assembly of Type Q Chip Trap, Type D Roto-Clone and Cycoil Aftercleaner exhausts from cast iron machining operation in a southern Ohio automotive plant. Note provisions for recirculation in wintertime and discharge out-of-doors in summer.

the concentration entering the Phase 2 collector was very low for the conventional type of dust collector.

To perform the task of collecting the heavier fraction, it was found that either a medium-efficiency centrifugal collector or a high-efficiency dry dynamic precipitator with chip trap precleaner could be used.

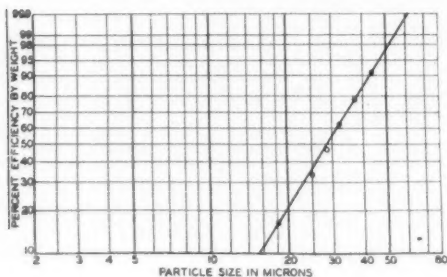


Fig. 7.

Efficiency of Skimmer Precleaner.

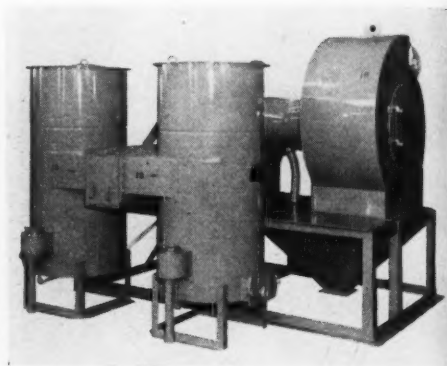


Fig. 6.

Typical assembly of Skimmer Precleaner, exhauster (hidden from view) and Cycoil final cleaners.

The selection of the final cleaner presented a more difficult problem.

The oil-bath type air cleaner appeared to have a number of advantages for this application:

1. While it had a higher pressure drop than the viscous type of air filter, engine and compressor installations showed that it was capable of handling higher dust loads with higher efficiency.
2. It used oil which did not evaporate and need not be replaced or renewed.
3. It occupied a minimum amount of space.
4. It could be designed with adequate dust storage capacity.
5. It was self-cleaning, requiring relatively little maintenance.

The present type of oil-bath air cleaner used for this application is shown in Fig.

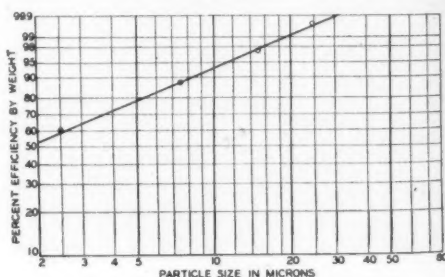


Fig. 8.

Efficiency of Cycoil.

4. Fig. 5 and Fig. 6 show the two different types of complete assemblies.

Laboratory Tests

USING a dust sample supplied by the interested company, laboratory tests were run using the two-stage equipment described above. It was found that the centrifugal collector efficiency was approximately 75% and the over-all efficiency of the assembly was 99.0%. The fractional efficiency curve for the centrifugal collector is shown in Fig. 7, and for the oil-bath air cleaner in Fig. 8.

Field Test

THE laboratory tests were sufficiently encouraging to proceed with the installation of 10 assemblies, each to have a capacity of 20,000 cfm. Several units selected by the owner as being typical were tested after they had been in operation for a few months. The results of these tests were:

Inlet concentrations 0.715 to 0.146 grains per cubic foot.

Outlet concentrations 0.00034 to 0.00098 grains per cubic foot.

Impinger samples were also taken of the air being discharged from the oil-bath cleaner back to the working area. Dust counts were then made of these samples. Results of counts are as follows:

Maximum—2.5 million particles per cubic foot

Minimum—1.55 million particles per cubic foot

Average—1.9 million particles per cubic foot

Screen analysis of material collected by dry centrifugal:

plus 150 mesh57.7%

150—200 mesh16.4%

220—325 mesh16.5%

passing 325 mesh 9.4%

The material collected in the oil-bath cleaner was de-oiled and examined under a microscope. The analysis *by count* was as follows:

Size (Microns)	Percent by count
1—5	66.7
5—10	20.3
10—20	8.1
20—40	4.65
Over 40	.25

Other Tests

THE success of this initial installation has since led to the use of a large number of assemblies of the type described. There are, at the present time, a total of 17 installations recirculating a total of 1,036,000 cfm from cast iron machining operations. One of these at a Michigan automotive plant was tested after it had been in operation for a full year. During the year of operation the oil had been drained and sludge removed from the oil-bath cleaner whenever necessary, but the pads had not been removed for cleaning. The air volume had not been reduced from the time the equipment was started up. The results of these tests were as follows:

Over-all efficiency of the equipment by weight.....99.5%

Dry centrifugal collector efficiency by weight75 %

Dust count before the oil-bath cleaner (MPPCF)26.0

Dust count after the oil-bath cleaner (MPPCF) 3.0

Oil-bath cleaner efficiency *dust count basis*88.5%

Other interesting data included the fact that of the material escaping the oil-bath cleaner, 80% by count was in the 1-3 micron range and no particles were larger than 5 microns.

Microscopic examination of some of the sludge collected by the oil-bath air cleaner showed the following size distribution *by count*:

Particle Size (Microns)	Percent
1—5	83.3
5—10	13.6
10—20	2.7
20—40	0.4
Larger than 40	0.0

Conclusions

THE installations described demonstrate that recirculation from exhaust systems handling non-toxic cast iron dust is effective and practical. The usual objections against recirculation have failed to appear.

On these installations, maintenance is reasonable. High efficiency collection has continued on units which have been in operation longer than a full year without any extended "down time" for overhaul. This experience justifies examination of ob-

jections to recirculation based on the contentions that efficiency of equipment falls off as use continues, and that continued efficiency necessary for recirculation can only be secured at the expense of frequent maintenance.

For installations of this type, if recirculation were not possible, exhaust ventilation would be unlikely owing to the large air volumes required to control the nuisance dust. The savings in improved housekeeping effected by the installation of a local exhaust ventilation system would be to a

large extent nullified by heat losses if the cleaned air had to be discharged out of doors. It should also be remembered that on the installations described, the concentration of fine particles is higher than the conventional metal working operations such as stand grinding, portable grinding, polishing and belt sanding. This would indicate that any equipment comparable to that described should be equally efficient in cleaning the exhaust from any of these operations to make recirculation effective for this entire group.

American Industrial Hygiene Association

—News of Local Sections—

Western New York

THE Western New York Section of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION was organized at a meeting of interested persons February 10, 1950, at the University of Rochester Atomic Energy Project, when the following officers were elected: MR. KARL DUNN, Corning Glass Works, president; DR. H. E. STOKINGER, University of Rochester Atomic Energy Project, secretary-treasurer; DR. J. H. STERNER and MR. H. C. CROUCH, both of Eastman Kodak Company, executive committee; DR. DAVID W. FASSETT, Eastman Kodak Company, president-elect. DR. M. L. AMDUR, Blanchard Industrial Clinic (Buffalo), with DR. E. C. RILEY, Eastman Kodak Company, as alternate, was later elected delegate to the A.I.H.A. Council meeting at Chicago. At the present time the membership of the section consists of 23 national members and 24 local members. Seventy-nine other interested persons from local industries attended one or more of the meetings. A list of the meetings

and speakers heard during the year follows:

Meeting No. 1: February 10, 1950: Organization and election of officers.

No. 2: June 1, 1950: Inspection of new atomic energy laboratories, including industrial hygiene teaching facilities, at the University of Rochester Atomic Energy Project.

No. 3: December 1, 1950: Symposium on safe handling of solvents in industry: (a) Summary of health hazards—DR. J. H. STERNER, Eastman Kodak Co. (b) Methods of controlling solvent exposure—DR. E. C. RILEY, Eastman Kodak Co. (c) Fire and explosive hazards—MR. EARL WALLACE, Eastman Kodak Co. (d) Demonstration of apparatus for detection and estimation of solvent concentrations—MR. G. C. CROSSMON, Bausch & Lomb Optical Company.

No. 4: February 13, 1951: Noise—nuisance or hazard?—DR. CHARLES R. WILLIAMS, Director of Applied Research, Liberty Mutual Insurance Co.

No. 5: March 28, 1951: Application of

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AND ASSOCIATES

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FORMERLY HEAD HYGIENIST
FORD MOTOR COMPANY

spectroscopy to analysis of toxic substances—DR. L. T. STEADMAN, Chief of Spectroscopy Section, University of Rochester Atomic Energy Project.

Election of Officers: DR. D. W. FASSETT, Eastman Kodak Co., president; DR. F. A. SMITH, University of Rochester Atomic Energy Project, secretary-treasurer; MR. SIDNEY LASKIN, University of Rochester, Atomic Energy Project, director; MR. G. C. CROSSMON, Bausch & Lomb Optical Co., president-elect; DR. H. E. STOKINGER, delegate to A.I.H.A. Council Meeting at Atlantic City.

Chicago

ON THURSDAY morning, October 11, the A.I.H.A. will co-sponsor with the American Society of Safety Engineers a session at the National Safety Congress in Chicago, Illinois. The program is as follows:

Industrial Hygiene and Safety Engineering: Thursday Morning, October 11, 1951:

9:45 A.M.—Industrial Dusts—What Every Supervisor Should Know—L. E. HAMLIN, M.D., American Brake Shoe Co., Chicago.

10:30 A.M.—Radiant Heat—Problems in Industry—Discussion and Demonstration—W. G. HAZARD, Owens-Illinois Glass Co., Toledo.

11:15 A.M.—Dermatitis—Termwork in Engineering and Medical Control—WALTER F. SCHOLTZ, Allis Chalmers Mfg. Co., Milwaukee; DR. CLIFFORD KALB, Clinical Allergist, Milwaukee.

Upper New York

ON JULY 20, 1951, the Upper New York Section met at Saranac Lake and devoted a full day to the July meeting. The program was as follows:

Introductory Remarks—ARTHUR J. VORWALD, M.D., Director, the Trudeau Foundation and The Saranac Laboratory.

"The Control of Radiant Heat in Hot Industries"—MR. KARL DUNN, Industrial Hygienist, Corning Glass Works.

"Industrial Hygiene in Mining at the Port Henry Division, Republic Steel Corporation":

Medical Aspects—DR. THOMAS J. CUMMINS, Medical Director.

Safety and Engineering—MR. RAY MUNSON, Superintendent of Industrial Relations.

"Certain Aspects of the Industrial Pneumoconioses"—The Saranac Laboratory Staff.

"Rehabilitation of the Disabled Industrial Worker"—MR. WILLIAM STEARNS, Director, The Saranac Lake Study and Craft Guild.

"Industrial Hygiene"—DR. WILLIAM P. YANT, Director Research and Development, Mine Safety Appliances Company.

Visit The Saranac Laboratory and Other Activities of The Trudeau Foundation.

Recent Deaths

MR. E. WARD THOMPSON died suddenly on June 11, 1951, of a heart attack. He had been in the employ of the American Mutual Liability Insurance Co. for 22½ years, and was well known in the field of industrial hygiene. He had been a member of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION since its establishment, and a past-chairman of the New England Section. He was also a member of the American Chemical Society, and of the Vermont Botanical Society.

LETTERS

Terminology

TO THE EDITOR: I was interested in your editorial, "Catalytic Incineration—A New Tool For Air Pollution Control," published in the June, 1951, issue.

During the past year I have had considerable experience with this new method of atmospheric pollution control and should like to comment on several phases of the problem it presents.

Since this method is relatively new I think those interested in the subject should come to some agreement on the terminology to be used, especially in any technical papers that may be written. For instance, consider the use of the word "incineration." I prefer "catalytic combustion," for the following reasons: (1) The effluent is essentially hydrocarbon vapors and atmospheric contaminants. In the presence of the catalyst the reaction between the hydrocarbons and oxygen forms water and carbon dioxide. The contaminants are oxidized in a similar manner or may be oxidized to a less irritant compound, depending upon the temperature rise at the catalyst. (2) When this exothermic reaction takes place there is a temperature rise, directly proportional to the potential heat energy content of the hydrocarbons in the effluent. I have seen this rise as high as 500° F. Usually with incineration there is no temperature rise greater than that supplied by the oil or gas flame. (3) Incineration denotes, reducing to ashes. Since the presence of non-flammable particulate matter is objectionable in this catalytic method of combustion, I think we should not use the term "incineration." In addition, the interchangeable use of the terms, "combustion" and "incineration" was confusing. The word "fume" is another word being used in connection with catalytic combustion, which is also confusing. It means one thing to the technical person in the field of industrial hygiene and atmospheric pollu-

tion control, another to the plant manager who gets the complaints from the neighborhood, and most anything to the general public. I prefer the word "effluent" to denote combustible hydrocarbons associated with atmospheric contaminants that are also combustible.

With regard to the fire hazards caused by hydrocarbon vapors, I know fire insurance companies have recently become aware of the problem and are in the process of drawing up a set of regulations. I have seen large installations which use natural ventilation only in the disposal of exhaust gas. To me, this seems dangerous. I would insist that all catalytic combustion installations have mechanical exhaust ventilation. It has been the practice not to place any resistance, however slight, in the piping of ovens where there was a high hydrocarbon content in the effluent, especially if there was only natural ventilation.

Another problem is how to use a minimum of instrumentation for indicating the continued activity of the catalyst once the optimum operating conditions were determined by chemical tests of the oven and stack effluents. Without this indication I can see how certain resinous products in the effluent (should the catalyst become inactive) could collect on the inactive catalyst, further increasing the resistance to the air, or effluent flow, and thus create a fire hazard.

—ALEXANDER E. GOSS

Suggestion

TO THE EDITOR: May I make a suggestion which may be worth consideration for incorporation in the *Industrial Hygiene Quarterly*?

It has been my opinion that the most valuable information gained at the National Meeting is that which is picked up in informal discussions rather than that presented in the formal papers which will appear later in print. At every meeting I hear of at least half

a dozen items of interest: new hazards, new processes which may give rise to hazards, results of small-scale research aimed only at solving an immediate problem, answers to questions which have been puzzling me, new methods or ideas. On the other hand, I frequently come across bits of information which may be of value to others but which are not worthy of a formal paper. I am sure that most of the other members have had the same experience.

I believe that a section in the *Quarterly*, possibly under the heading of Miscellaneous, would be of value as a source of exchange of ideas or information. It could be limited to items of one or two paragraphs covering topics such as new processes, new hazards, results of small-scale research, negative results of research, about which formal papers seldom appear, or questions which could be answered in succeeding issues or directly by letter by other members. The information could be presented informally to encourage greater participation. In some cases, it probably would have to be presented anonymously because of secrecy involved.

If you feel that this suggestion is worthy of consideration, I shall be glad to assist in securing enough of these items for a trial run.

—JOHN J. FERRY

EDITOR'S NOTE: In the June issue of the *A.I.H.A. Quarterly* we published a paper under the title of "Industrial Hygiene in West Germany" by DR. LUDWIG TELEKY. Owing to untoward circumstances, it was necessary to delete much of the material appearing in the original manuscript. For those of our readers who are interested in obtaining the deleted portions of the text, DR. TELEKY has on file mimeographed copies of the original manuscript. These can be obtained by writing directly to him at 96 Wadsworth Terrace, New York 33, New York.

BACK ISSUES AVAILABLE

Single copies; of nearly all issues to the AIHA Quarterly, since its appearance in June, 1946, as a separate journal, may be obtained from the Executive Secretary.

BOOKS

Industrial Hazards

THE BRITISH MEDICAL BULLETIN: "Industrial Hazards," Vol. 7, Number 1-2, 1950, Oxford University Press, 114 Fifth Ave., New York 11, N.Y., pp. 143, \$2.00.

It is a truism that no medical book is truly new by the time it is published. It is not an extraordinary occurrence that two or three years elapse between the author's "finis" and the publisher's "for sale." This is not equally true of journal publications. As little as two weeks on occasion may lie between author and the journal reader. Some of the newest, crispest disclosures in the industrial physician's field of action appear in special issues of journals not peculiarly dedicated to occupational health. This is true of the issue of the British Medical Bulletin under present scrutiny. This special issue affords the near immediate state of medical thought as to byssinosis, the radiation syndrome, the newer insecticides, industrial fluorosis, the pneumoconioses, metal poisoning, industrial solvents, occupational dermatoses—to mention about half the items listed. It is true that these articles possess a British flavor. If there be difference in experiences, it becomes desirable that all experiences enter a common appraisal. Occupational diseases are scarcely nationalistic. Whimsically it has been said of the recently deceased author Stephens: "He was a native of Ireland and Fairyland." So as to occupational diseases, they may be natives of all industrial lands.

Radioisotopes

RADIOISOTOPES. Industrial Applications: G. H. GUEST, Senior Scientific Officer, Health Radiation Section, Industrial Health Division, Department of National Health and Welfare, Ottawa, Canada. Illustrated. Pitman Publishing Corporation, New York, 1951, pp. 185.

A RECENT survey by the University of Michigan (which has nothing to do with this book) determined that among large numbers of persons living near to atomic energy installations and others somewhat remoter, one in a hundred never heard of "radiation" and 8% of persons living near an atomic energy plant never heard of its existence. Then it is high time that books like this one of Guest's should be written and read. This book which is general in its coverage in simple terms of all aspects of radioactive isotopes is pointed to many applications already found useful by

industry. Every example briefly described is engaging. Two of such are mentioned here. In the pipeline conveyance of petroleum oils often it is desirable to determine just where the head of a given lot has reached over a possible traversed distance of hundreds of miles. In an earlier day it was necessary to drain off samples and carry out some form of analysis, chemical, colorimetric or otherwise. Now the head may be established from outside the line merely by application of the Geiger counter to detect the arrival of oil treated at the point of introduction with some relatively harmless radioactive agent. In an unrelated instance it was pointed out that in the paper pulp industry it becomes necessary to remove all of unwanted chemicals utilized in the digesters. In an uncontrolled system endless washings may be conducted on an arbitrary basis. To save time and money and to provide accuracy it is only necessary to add radioactive tracers to the chemicals and in due course measure. When radioactivity disappears—no more washings. A hundred more examples radiate.

Any industry large enough to support a plant medical department (and many smaller ones) is likely applying isotopes in its processes or planning such. The industrial hygienist has a stake in the provision of security against potential harm in these procedures. Unless prepared to take a hand the hygienist may become a statistic in the University of Michigan's next round. To avoid becoming statistically stigmatized about radioisotopes, read this book.

Smog

THE SMOG PROBLEM IN LOS ANGELES COUNTY: Third Interim Report, Committee on Smoke and Fumes, Western Oil and Gas Association, Los Angeles, 1951, pp. 60.

SLOWLY the mystery and menace of smog reveal themselves. This beautifully illustrated Third Interim Report on Los Angeles County is befogged by no smog of its own. The authors' modest summary speaks for itself: "Smog is man-made air pollution that causes nuisance. In Los Angeles, smog is not a single impurity, but a complex mixture of gases, solid particles, and liquid droplets. The burning of nearly 50,000 tons a day of fuels and rubbish is believed to be the principal cause of smog in Los Angeles County. Research during 1950 shows further that this burning by the public and industry emits to the air each day at least 2000 tons of chemicals which can cause poor visibility, eye irritation, and other smog effects. Of the total

combustion and evaporation products put into the air daily, about 40% come from industrial sources and 60% come from activities of the general public, such as driving automobiles, trucks, and buses, burning garden trash, and heating homes, stores, and office buildings. Of the significant chemicals discharged, the activities of the general public are responsible for about 75% of the organic materials, 65% of the aldehydes, 65% of the ammonia, 40% of the nitrogen oxides, 30% of the acids, and 25% of the sulphur oxides. Industry is responsible for the remainder in each case. Gases derived from burning organic matter are the principal substances found in smog and are invariably associated with eye irritation. Reduced visibility, on the other hand, is caused by solid particles and liquid droplets. Los Angeles is not unique in having air pollution, but the area has more frequent smogs than most because of the seasonal weak winds and temperature inversions that occur over a basin confined by mountains on three sides. There have been no basic changes in the Los Angeles climate to explain the increased frequency and severity of smog in recent years. All evidence indicates that this trend has been due to the steady increase of human activity in the area. This activity is that of the individual citizens as well as the collective enterprise. Los Angeles smog is a community problem. It can be abated only by community action."

This brochure asks and answers these questions: What is smog? Why is there smog in Los Angeles? What reduces the visibility? What causes eye irritation? Where do the air pollutants come from? Where do we go from here?

The highly technical report is disguised in simple language that he without a Ph.D., may read and profit.

Radiation Monitoring

RADIATION MONITORING IN ATOMIC DEFENSE: By DWIGHT E. GRAY, and JOHN H. MARTENS. D. Van Nostrand Co., Inc., New York, 1951, pp. 122, illustrated, \$2.00.

GUIDED by precedent, the jacket blurbs of the publisher of any scientific book sometimes require sieving to remove parental over-enthusiasm. Restraint has so governed the present publishers that their estimate of the worth of this small volume is a faithful portrayal of just what the book contains, why it was written, and its places of use. The reviewer defers to the publisher: "This is a scientific, how-to-do-it book, written for everyone concerned with the measurement of

atomic radiation. It is of vital interest to radiological defense personnel in civilian defenses and in the armed forces; hospital and industrial users of radioisotopes (in health protection work); all users of Geiger and other radiation counters.

"Prepared by authors thoroughly qualified to present reliable, authoritative and dependable information, it is based on the radiological plans and techniques as developed by the Federal Civil Defense Administration and the Atomic Energy Commission and set forth in (1) The Effects of Atomic Weapons, (2) United States Civil Defense (NSRB), and (3) Civil Defense Radiological Monitoring Instruments Specifications issued by the Federal Civil Defense Administration.

"The radiation monitor (or Geigerman) needs information not only about the nature, characteristics, and operation of his instruments, but, if he is to do his work properly, about certain fundamentals of atomic energy and the release of atomic radiation. He must know, too, the relation of atomic radiation to the dangers and phenomena which accompany an atomic explosion. This book is designed to supply these needs. Part I is devoted to background information, presented in a form that can be understood readily by readers with no technical background. It describes the basic concept of atomic energy and radiation, and the kinds of hazards that are produced during and just after an explosion, and those that may continue for some time. It then considers the protective measures that can be taken against atomic explosions, and concludes with a detailed study of the detection and measurement of the nuclear radiations. Part II is devoted to the instruments and equipment used in radiation detection. Chapters are given to the Geiger Counter Survey Meter, the Ionization Chamber Survey Meter, the Proportional Alpha Counter, Pocket Chambers and Dosimeters, and Film Badge Dosimeters. The constituents and use of the AEC Emergency Monitoring Kit are described. In all cases, the machines discussed are typical ones, and the book can be used with any type of equipment now in the market and adapted to practical defense work."

The book was not written exclusively for the physicist at Oak Ridge, or the professor at the University, or the Civilian Defense monitor. In part, but not by mention, it was written for those industrial physicians and hygienists who see in radioactive isotopes an approach to the solution of their own peculiar medical and process difficulties, but are deterred by the perils of radiation. This book eliminates the unnecessary worry.

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